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This report contains air pollutant emissions estimates, air quality data and dispersion modeling for the base year (present) in AQMA counties in the State of North Dakota. Projections of emissions and air quality (using dispersion modeling) are made for 1980 and 1985. The adequacy of the existing North Dakota State Implementation Plan to provide for the attainment and maintenance of the National Ambient Air Quality Standards is discussed.

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NORTH DAKOTA AIR QUALITY MAINTENANCE AREA ANALYSIS

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Contract No. 68-02-1375
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CONTENTS

		Page
1.	INTRODUCTION	1-1
2.	SUMMARY	2-1
3.	McLEAN-MERCER-OLIVER AQMA	3-1
4.	CASS COUNTY AQMA	4-1
	REFERENCES	R-1
	APPENDIX	
A.	NORTH DAKOTA AQMA POINT SOURCE SUMMARY	A-1
B.	AIR EMISSION SOURCES FROM A LURGI DRY-ASH GASIFICATION FACILITY USING LIGNITE COAL	B-1

FIGURES

No.		Page
1.1	North Dakota AQMA's	1-2
3.1	McLean-Mercer-Oliver AQMA Analysis Area	3-4
3.2	Area Source Grids	3-9
3.3	Receptor Locations	3-23
3.4	1974 Geometric Mean Particulate Concentrations	3-28
3.5	Predicted 1980 Geometric Mean Particulate Concentrations	3-31
3.6	Predicted 1985 Geometric Mean Particulate Concentrations	3-32
3.7	Predicted 1985 Annual Arithmetic Mean SO_2 Concentrations	3-35
4.1	Cass County AQMA Analysis Area	4-4
4.2	Area Source Grids for Cass County	4-7
4.3	Receptor Locations	4-11
4.4	1974 Geometric Mean Particulate Concentrations in Cass County AQMA	4-14

TABLES

No.		Page
1.1	National Ambient Air Quality Standards for Designated Pollutants	1-3
2.1	Results of AQMA Analyses	2-2
3.1	Locations of Point Sources	3-8
3.2	Comparison of Estimated Annual Lignite Consumption from Coal Impact Study and from Megawatt Capacity	3-11
3.3	Point Source Emissions in Analysis Area	3-13
3.4	Area Source Particulate Emissions for McLean-Mercer-Oliver Counties	3-14
3.5	Area Source Emissions of SO_2, Hydrocarbons, and Oxides of Nitrogen for AQMA Counties	3-15
3.6	Apportioning Factors by Source Category	3-16
3.7	Particulate Emissions by Grid and Source Category, 1974	3-17
3.8	Particulate Emissions by Grid and Source Category, 1980	3-18
3.9	Particulate Emissions by Grid and Source Category, 1985	3-19
3.10	Comparison of Model-Predicted and Measured Pollutant Concentrations in AQMA Analysis Area (Annual Averages)	3-26
3.11	Comparison of Model-Predicted and Measured Pollutant Concentrations in AQMA Analysis Area (Short-term Peak)	3-30
3.12	Source Contributions to Predicted 1985 Ambient Concentrations at Selected Receptors	3-34

No.		Page
3.13	Oxidant Sampling Data--Selected Sites in EPA Region VIII	3-38
3.14	Ozone Data for Ohio, Pennsylvania, and Maryland	3-40
3.15	County-Wide Hydrocarbon Emission Densities	3-42
4.1	Particulate Emissions for Cass County	4-5
4.2	Cass County Emissions by Grid and Source Category, 1974	4-9

1. INTRODUCTION

The North Dakota Department of Health, Environmental Engineering Division has identified two areas that have the potential of exceeding the National Ambient Air Quality Standards (NAAQS) because of existing air quality and/or projected growth over the next ten years (1975 to 1985). The U.S. Environmental Protection Agency has published these areas as designated Air Quality Maintenance Areas (AQMA's). The two AQMA's are McLean-Mercer-Oliver and Cass County. McLean-Mercer-Oliver is designated for four air pollutants: particulates, sulfur dioxide, oxidants, and oxides of nitrogen. Cass County is only designated for particulates. Figure 1.1 shows the location of the two AQMA's.

Once designated as an AQMA, a detailed analysis of the impact of projected growth on air quality is required. This report presents such an analysis for the two areas.

If the AQMA analysis demonstrates that neither the primary nor secondary NAAQS will be exceeded, no plan for maintenance of standards is required and the AQMA can possibly be de-designated. However, should the analysis show a problem in attaining the NAAQS by 1975 and/or maintaining the standards in the future, revisions to the North Dakota State Implementation Plan (SIP) and development of an air quality maintenance plan will be required.

The procedures used in the AQMA analysis are consistent with the proposed regulations on maintenance of National Ambient Air Quality Standards, 40 CFR, Part 51.[1] Table 1.1 shows the primary and secondary NAAQS for the four designated pollutants. A ten year projection period has been

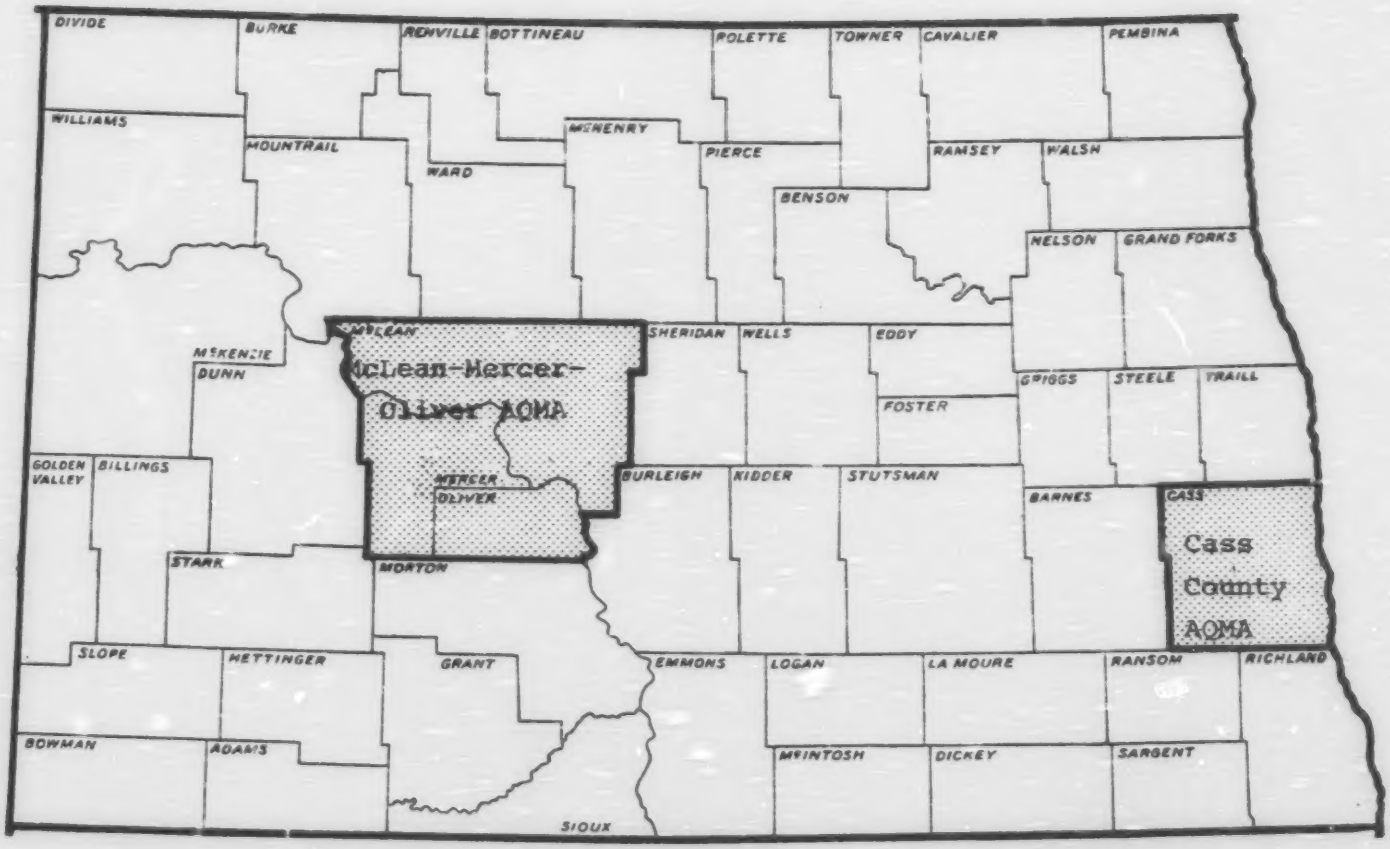

Figure 1.1. North Dakota AQMA's.

Table 1.1. NATIONAL AMBIENT AIR QUALITY STANDARDS FOR DESIGNATED POLLUTANTS

Pollutant	Frequency	Primary NAAQS, ug/m^3	Secondary NAAQS, ug/m^3
Suspended particulate	Annual geometric mean	75	60
	Maximum 24 hours[a]	260	150
Sulfur dioxide	Annual arithmetic mean	80	
	Maximum 24 hours[a]	365	
	Maximum 3 hours[a]		1300
Nitrogen dioxide	Annual arithmetic mean	100	100
Photochemical oxidants	Maximum 1 hour[a]	160	160

[a] Not to be exceeded more than once per year.

used in both AQMA's. In McLean-Mercer-Oliver, "208" water planning activities for the Lewis & Clark planning area have not yet developed demographic projections. The only other federally-sponsored planning program, the Northern Great Plains Resource Program, employed a ten year projection period because reliable data on energy-related development were not available beyond that time span. In Fargo, the current regional land use plan has a projection year 2000, longer than the normal analysis interval for AQMA planning. Fargo is not part of a "208" planning area and no other federally-sponsored planning programs were identified in the AQMA. Therefore, the ten year period recommended in the AQMA guideline documents was also used here.

A base year of 1974 was used in validating the AQMA modeling. This was the most recent year for which complete data could be obtained. Projection years of 1980 and 1985 were used since they marked the midpoint and end of the ten year analysis period and fulfilled the requirement in the guidelines of analyzing for five year intervals. Emission projections were also developed for the year 1975, but this year was dropped from the analysis because emissions were not significantly different than in 1974.

The AQMA analysis focuses on projected annual average concentrations. Short-term maximum concentrations were calculated, but were not considered to be as important in the analyses due to the increased uncertainty of predicting short-term variations in future occurrences and of determining the joint probability of maximum predicted emission rates coinciding with adverse meteorological conditions. The analyses of annual concentrations were considered sufficient for identifying attainment and maintenance problems.

This report is divided into three additional chapters: Chapter 2 summarizes the findings of the two AQMA analyses;

Chapter 3 includes a detailed analysis of the McLean-Mercer-Oliver AQMA for all four pollutants; and Chapter 4 presents the detailed analysis of the Cass County AQMA for particulates.

2. SUMMARY

The analyses in both AQMA's utilized current, comprehensive emission inventory data and state-of-the-art regional diffusion modeling to predict ambient pollutant concentrations from emission estimates. In the McLean-Mercer-Oliver AQMA, projections of future development were exceptionally good because of several recent studies that identified specific facilities to be located in the area and their expected secondary impacts on population, traffic, construction, etc. In Cass County, almost all the emissions were shown to be from area sources, and projections were available for each area source category. The AQMA analyses followed procedures prescribed in proposed Federal regulations (40 CFR Part 51, Subpart D) and in the series of AQMA guideline documents prepared by EPA. Therefore, the analyses are considered to be complete and to contain best available data and procedures.

The analyses showed that annual standards will be maintained in both AQMA's with existing air pollution control regulations. The findings are summarized in Table 2.1. Standards were shown to be maintained by a wide margin in McLean-Mercer-Oliver, where ambient levels are projected to be only slightly above background even after anticipated startup of a coal gasification plant, several power plants, and new coal mines by 1985. Even though there will be several large-scale developments, they will be spread over many miles (much larger area than a city occupies) and do not appear to increase ambient concentrations substantially in combination because of the distances between sources.

Table 2.1. RESULTS OF AQMA ANALYSES

AQMA	Pollutant	Highest predicted concentration in AQMA, ug/m^3	Applicable annual standard, ug/m^3
McLean-Mercer-Oliver	Particulate[a]	32	60
	SO_2	8	80
	NO_x	3	100
Cass Co.	Particulate[a]	48	60

[a] Values shown are geometric mean; for other pollutants, the values are arithmetic mean.

The sources will have to meet applicable New Source Performance Standards; tall stacks on the proposed point sources also act to disperse their ground-level impacts. Finally, the AQMA has been designated a Class II area for prevention of significant deterioration, so the allowable increments of deterioration for particulates and SO_2 would be violated long before the air quality standards are exceeded. A possible Class I designation for the Fort Berthold Indian Reservation in western McLean County would result in an even more restrictive air quality increment for new development and provide additional assurance that standards would be maintained.

Analysis for maximum 24-hour levels indicates that these standards will also be maintained by a wide margin. Therefore, the need for an air quality maintenance plan to protect ambient standards in the McLean-Mercer-Oliver AQMA from being exceeded is not anticipated.

No changes in particulate air quality are expected in the Cass County AQMA during the next ten years. Presently, concentrations at the level of the annual secondary standard are being recorded at one sampling site in Fargo; two others (one in Moorhead) have readings of about 50 ug/m^3 geometric mean. County-wide emission totals would seem to indicate high concentrations in rural parts of the county (94 percent of particulate emissions in the county are from unpaved roads and agriculture), but modeling shows that concentrations in the rural areas are only slightly above background and that all high concentrations are in the Fargo-Moorhead urban area. Point sources, mainly grain milling and storage elevators, are shown to contribute about half of the concentrations (above background) at these receptors. In checking this apparent contradiction, it was determined that the highest emission densities do occur in the urban area and that the rural emissions are very uniformly distributed throughout the remainder of the county.

The short-term particulate standards will probably continue to be exceeded in Cass County as a result of uncontrollable natural sources. On infrequent occasions, less than 10 percent of the sampling days, all sampling sites in and near the AQMA record concentrations above either the primary or secondary standard. Since the frequency of violations is approximately the same at the background sampling site as at the urban sites, it was concluded that the contributing sources are probably either agriculture-related or from long-range transport. In either case, an attainment plan would be incapable of preventing the violations.

The one-hour maximum standard of 0.08 ppm (160 ug/m^3) for photochemical oxidants will probably continue to be exceeded in the McLean-Mercer-Oliver AQMA solely as a result of natural sources. However, it was concluded that any increase in oxidant concentrations attributable to new hydrocarbon sources in the AQMA should be minimized by means of a plan to control hydrocarbon emissions from new stationary sources.

In summary, the analyses for the North Dakota AQMA's indicate that the only pollutant/AQMA requiring a maintenance plan is for photochemical oxidants (hydrocarbon control) in the McLean-Mercer-Oliver AQMA.

3. McLEAN-MERCER-OLIVER AQMA

ANALYSIS AREA

The McLean-Mercer-Oliver AQMA was designated as a Natural Resource Development Area under the concept that the high intensity of coal mining and related energy projects proposed for this area in combination might cause air quality standards to be exceeded in the future, even though the demographic projections used to identify regions with potential for rapid growth do not show a substantial change from the present rural, agricultural character of this area within the next 10 to 20 years.

The three county AQMA is located in the west central part of the state, to the northwest of Bismarck-Mandan. It has a land area of 3827 square miles (70 mi east-west by 60 mi north-south) that is presently about 95 percent farmland. Almost 27 percent of McLean County, about 550 square miles, is the Fort Berthold Indian Reservation and not under the direct jurisdiction of state regulations.

Terrain varies from flat to rolling, with the sharpest terrain features along river valleys. The area is bisected by the Missouri River and Garrison Reservoir, with McLean County to the northeast of the river and Mercer and Oliver Counties to the southwest. The only bridge across the river between these counties is at Washburn.

The estimated 1974 population of the AQMA was 20,400. The three largest towns--Garrison in McLean County and Beulah and Hazen in Mercer County--have populations of 1,200 to 1,700 each. Population projections used in the AQMA Area

Source Emission Inventory[2] indicate a large percentage increase in population to 35,500 in 1980 as a result of manpower necessary to construct and operate the proposed facilities. However, by 1985 the stable population of the area is projected to return to about 25,000 with the out-migration of the construction workers and their families. If more energy-related facilities are located in this AQMA in the following decade, population could remain near the 1980 peak.

Much of the land in the three county area contains commercially recoverable deposits of lignite coal. Three large power plants in the AQMA are already using this lignite and three more power plants, expansion of existing plants, and a coal gasification plant are in the design or construction stages. New mines will be opened to serve these additional plants.

After the boundaries of the AQMA were established, plans to build another coal gasification plant in Dunn County, about 20 miles west of the Mercer-Dunn County line, were announced. This plant is projected for completion in 1982, and may be followed by additional coal gasification plants in the same county. Therefore, emission data and projections have also been assembled for Dunn County as part of the AQMA analysis so that the air quality impacts of energy development in that adjacent county can also be determined.

In order to maintain the degree of resolution necessary to accurately locate concentration gradients with the atmospheric dispersion model, the entire three county AQMA plus Dunn County cannot be efficiently modeled as a single unit. To include an area of 70 mi by 60 mi, receptor sites in the model would have to be spaced at unacceptably large intervals or computer running time would be prohibitive if a close receptor spacing were used. Therefore, a smaller

analysis area which should encompass the points of highest ambient concentration in the AQMA has been specified. This analysis area is shown in Figure 3.1. All existing and projected point sources except a few small grain elevators in McLean County and the proposed coal gasification plant in Dunn County are included in this area. Since it is estimated that the Dunn County coal gasification plant will have the same emissions as the one in the analysis area, it should not contribute to as high ambient concentrations as the one in Mercer County because it is not surrounded by other large point sources.

The analysis area also encompasses the towns with the greatest potential for growth in the AQMA.[3] Because of the limited access across the Missouri River, the population influx is predicted to concentrate in Mercer and Oliver Counties near the new employment centers.

METHODOLOGY

The AQMA analysis for suspended particulate, SO_2, and NO_x is based on the use of regional dispersion modeling to predict ambient concentrations throughout the analysis area in the base year and two projection years for comparison with the air quality standards. The methods used in the AQMA analysis are consistent with those described in the EPA guideline series for air quality maintenance planning and analysis. Volume 12 of the guidelines, Applying Atmospheric Simulation Models to Air Quality Maintenance Areas,[4] was used to review available models for application in the McLean-Mercer-Oliver AQMA. The models selected and their required input data are described below. A separate analysis was performed for photochemical oxidants; it is presented at the end of this chapter.

A 208 planning agency has been designated for the same boundaries as the AQMA, but the agency has not yet developed

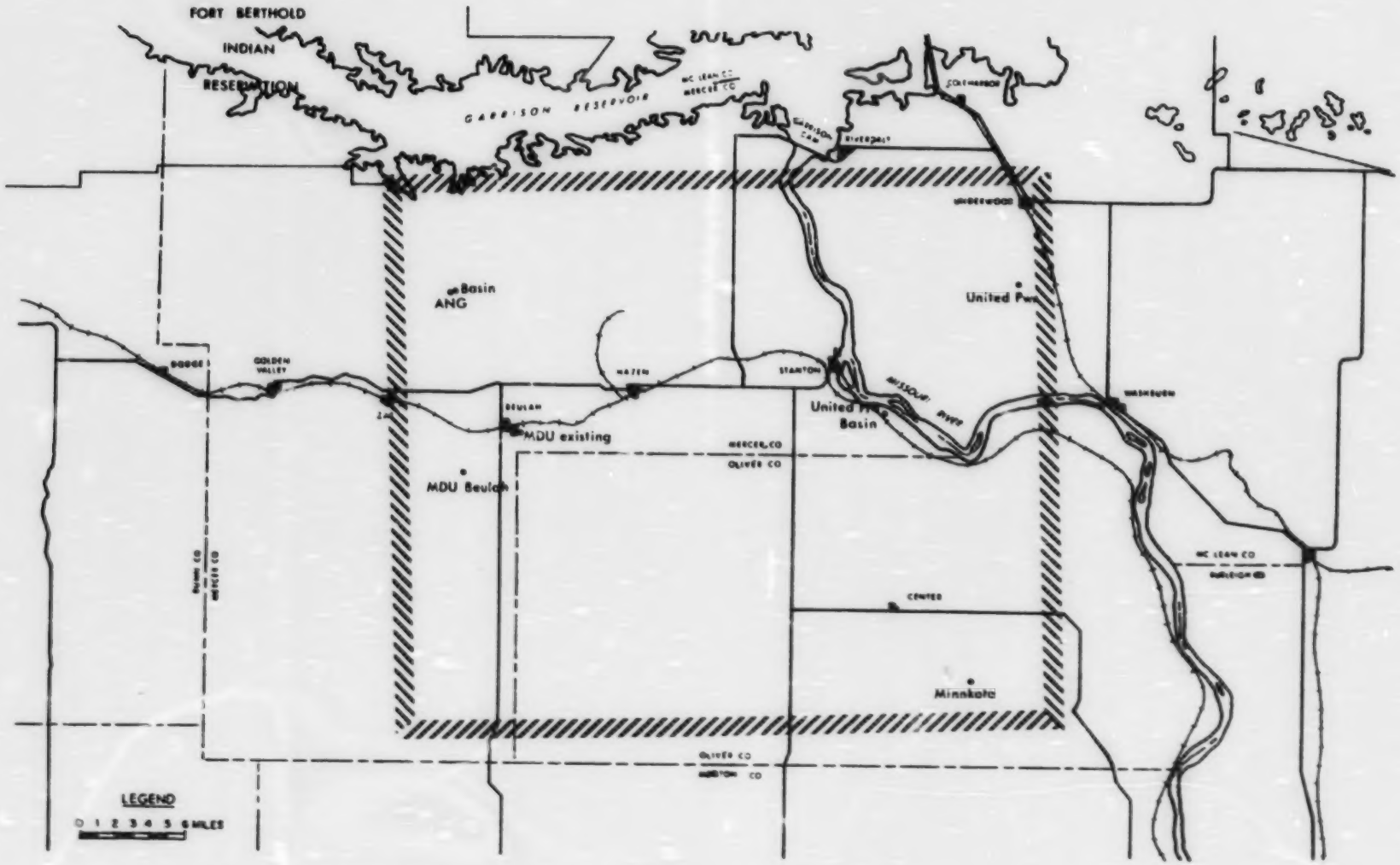

Figure 3.1. McLean-Mercer-Oliver AQMA analysis area.

projections for future development of the area. After the 208 projection data are released, they will be compared with those used in the present analysis for consistency, and any necessary changes in the analysis will be made at that time.

The only deviation from standard methodology in performing the AQMA analysis was in projecting emissions for point sources in future years. No growth factors were used. Instead, existing sources were assumed to continue emitting at their current rates (with the exception of one source scheduled for shutdown in 1977) and all new sources and expansion of existing sources were identified specifically, with emission estimates being made from available information. Data on the size, location, and startup date for proposed sources obtained from the Northern Great Plains Resource Program,[5] the State Division of Planning's Coal Impact Study,[6] and directly from the developers were all in agreement. Although this projection method neglects any unannounced new point sources that would locate in the AQMA during the next 10 years, it is probably far more accurate than analyses using growth factors to estimate future emissions and land use planning data to allocate these increased emissions to locations within the AQMA.

Modeling

Two multiple-source atmospheric dispersion models are available with capabilities of predicting annual average pollutant concentrations throughout a study area: Air Quality Display Model (AQDM)[7] and Climatological Dispersion Model (CDM).[8] Both of these models employ Gaussian plume dispersion and frequency distributions of annual meteorological conditions. The version of CDM on the Department of Health's computer has the capability for calculating source contributions at specified receptor sites (not in the version distributed in UNIMAP). Since CDM is a second generation multiple-source model and includes some improvements

over AQDM such as consideration of differences in daytime and nighttime dispersion characteristics, CDM was selected for use.

The CDM is applicable for flat or rolling terrain. It predicts annual arithmetic mean concentrations at any number of receptor sites for two pollutants--particulate and SO_2 in this case. The model adds a constant background concentration to values predicted at each receptor site by the dispersion calculations. The predicted concentrations can also be calibrated by comparison with concentrations measured at sites within the area being modeled. The slope of the line of best fit between measured and predicted concentrations is used to correct for persistent over- or under-prediction and the correlation coefficient provides an estimate of the accuracy of the simulation model.

The following input data are required for CDM:

Description	Format
Source locations	UTM coordinates
Source emission rates	Tons per year
Stack parameters	Stack height and diameter, exit temperature and flow rate
Meteorology	Joint frequency distribution of 16 wind directions, 6 wind speeds, and 6 stability classes
Receptor locations	UTM coordinates
Background concentration	Annual arithmetic mean

Potential 24-hour maximum concentrations in the AQMA were simulated with another model, the PEDCo Dispersion Model (PDM). The model is analogous to CDM in many aspects, but utilizes hourly meteorological and emissions input data and predicts short-term concentrations for averaging times from one to 24 hours. Meteorological input data include wind speed, wind direction, stability class, mixing height, and temperature.

The following sections discuss the input data used in the McLean-Mercer-Oliver analysis.

Source Locations

The locations of major existing and proposed point sources in the AQMA are shown in Figure 3.1. Universal Transverse Mercator (UTM) coordinates for the existing sources were obtained from NEDS listings and checked by locating the sites on USGS quadrangle maps. The UTM coordinates for new sources were determined by locating proposed sites on USGS maps based on information provided by the developers. As indicated previously, the identification of new sources was accomplished by comparing information on energy development projects from several different studies and information sources,[3,5,6,9] all of which were in substantial agreement. The UTM coordinates for all point sources in the analysis area are listed in Table 3.1.

The spatial distribution of area sources was specified by means of a grid system. Area source emissions were apportioned into 10 km square grids covering the entire analysis area. The locations of the 30 area source grids and their assigned numbers are shown in Figure 3.2.

Source Emission Rates and Stack Parameters

Pollutant emissions were divided into two categories for purposes of modeling--point sources and area sources. Point source emission data for the base year 1974 and stack parameters were obtained from file data in NEDS format, as summarized in Appendix A. Emission estimates for new power plant point sources were based on announced megawatt capacities of the plants, assumed load factors of 85 percent, and emission rates equal to the Federal New Source Performance

Table 3.1. LOCATIONS OF POINT SOURCES

Source name		UTM coordinates, km X	Y
1974			
1.	Farmers Elevator & Mercantile	339.0	5258.0
2.	Underwood Elevator	339.0	5258.0
3.	Basin I	324.3	5238.9
4.	MDU Boiler 1	290.0	5238.0
5.	MDU Boiler 2	290.0	5238.0
6.	MDU Boiler 3	290.0	5238.0
7.	MDU Boiler 4	290.0	5238.0
8.	MDU Boiler 5	290.0	5238.0
9.	United Power, Stanton	323.7	5239.5
10.	Beulah Farmers Elevator	290.0	5237.7
11.	Beulah PV Elevator	290.0	5237.7
12.	Hazen Farmers Elevator	302.0	5241.0
13.	Minnkota Power	332.0	5213.7
New, by 1980			
14.	Basin II	324.3	5238.9
15.	Minnkota Unit 2	332.0	5213.7
16.	United Power, Underwood	338.0	5250.0
New, by 1985			
17.	MDU Beulah 1	287.0	5233.0
18.	MDU Beulah 2	287.0	5233.0
19.	Basin III[a]	324.3	5239.0
20.	Basin Beulah	286.1	5250.2
21.	ANG Coal Gasification	286.0	5250.2
22.	ANG coal dust	286.3	5250.3

[a] Location still tentative.

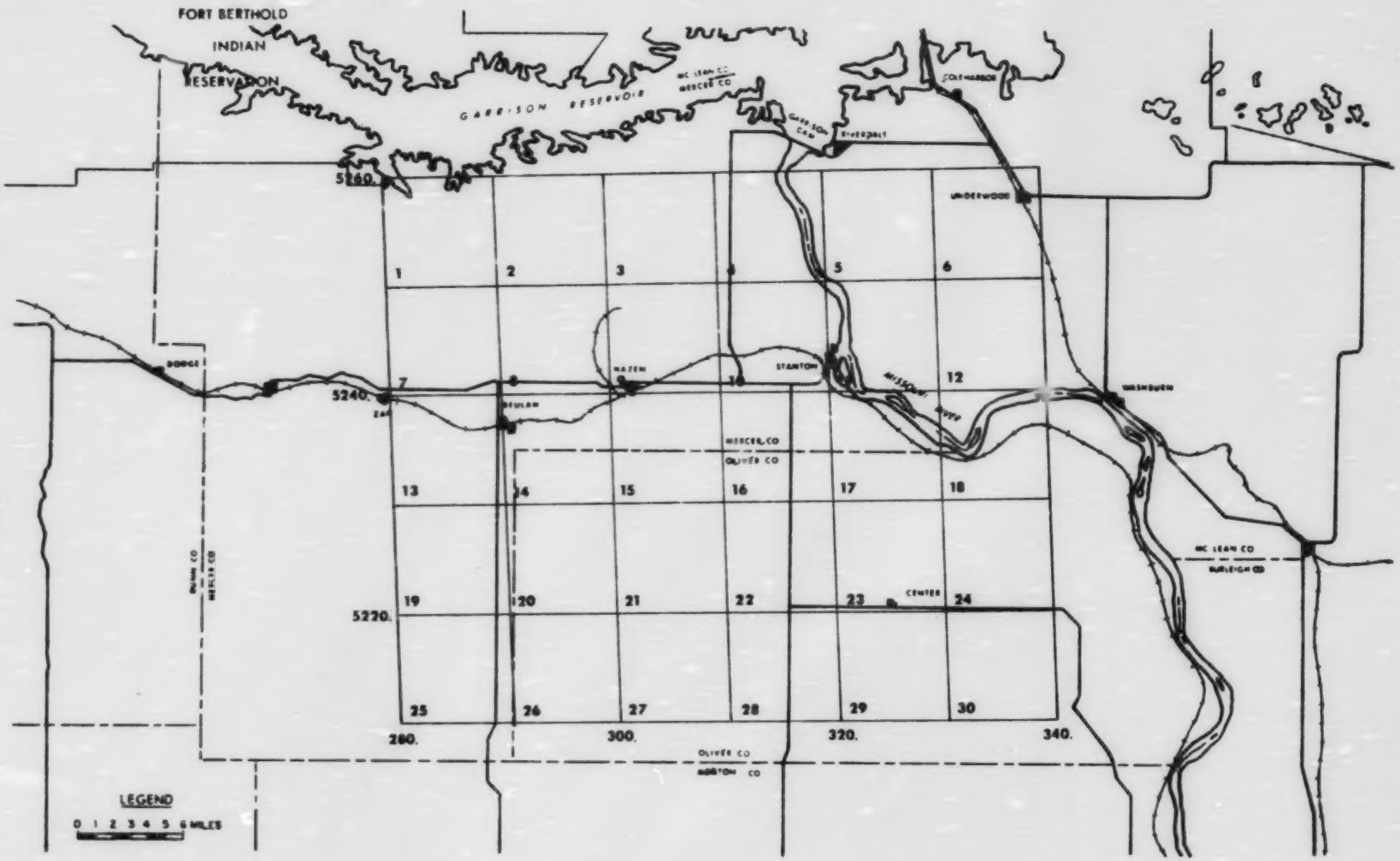

Figure 3.2. Area source grids.

Standards (NSPS) for fossil-fuel fired steam generators:

$$\text{Particulate} = 0.1 \text{ lb}/10^6 \text{ BTU input}$$
$$SO_2 = 1.2 \text{ lb}/10^6 \text{ BTU input}$$
$$NO_x{}^a = 0.6 \text{ lb}/10^6 \text{ BTU input}$$

This method may overestimate actual emissions from the new sources because many will have emission rates less than the NSPS. The estimates of operating times using the value of 85 percent of capacity (and the additional assumptions of 6500 BTU/lb for the lignite and 10,000 BTU/kwh conversion efficiency) appear to agree quite well with estimates from the Coal Impact Study report[6] of coal consumption at the proposed plants, as shown in Table 3.2. The following stack parameters were used for new power plant units for which specific information could not be obtained:

Stack height = 550 ft
Stack diameter = 20 ft
Exit velocity = 60 ft/sec
Temperature = 380° F

For the ANG coal gasification plant, emission estimates and stack data were obtained from the environmental impact report.[9] These emission estimates were compared with independent calculations (see Appendix B) based on data in the literature and appeared to be reasonable. The same emission data were assumed for the proposed Natural Gas Pipeline plant in Dunn County, although this source was not included in the model because it was considerably outside the analysis area.

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[a] The performance standard for nitrogen oxides from lignite fired plants is only a proposed standard at the present time.

Table 3.2. COMPARISON OF ESTIMATED ANNUAL LIGNITE CONSUMPTION FROM COAL IMPACT STUDY AND FROM MEGAWATT CAPACITY

Plant	MW rated capacity	Lignite usage, ton/yr[a]	Lignite consumption from Coal Impact Rpt., ton/yr
MDU Beulah	440	2,520,000	2,500,000
Basin I Stanton	212	1,214,000	1,200,000
Basin II Stanton	440	2,520,000	2,500,000
Basin Beulah	440	2,520,000	2,500,000
Minnkota	234	1,340,000	1,500,000
Minnkota II	440	2,520,000	2,800,000
United Stanton	172	985,000	850,000
United Underwood	950	5,442,000	5,500,000

[a] Based on BTU value of 6500 BTU/lb for lignite, conversion efficiency of 10,000 BTU/kwh, and 85 percent load factor.

Point source emission data used in the CDM model for the base year and projection years are summarized in Table 3.3.

Area source emissions and projections by source category on a county-wide basis were obtained from the North Dakota AQMA Area Source Emission Inventory.[2] Tables 3.4 and 3.5 show summaries of these emissions. A detailed description of the procedures used to estimate and project the area source emissions can be found in the inventory report. The three area source categories with most particulate emissions--unpaved roads, agriculture, and mining--are all fugitive dust sources. Unpaved road emissions were estimated from data on vehicle miles of travel on county roads provided from EPA's Compilation of Air Pollutant Emission Factors, Supplement 5. Agricultural emissions were based on the number of acres planted in different crops and emission rates derived from U.S. Department of Agriculture's wind erosion equation. Fugitive dust emissions from lignite surface mining were estimated by surveying the operations at one mine in Mercer County and calculating emissions by operation. These estimates were expressed in terms of lb/ton of coal mined for use in determining emissions from other mines in the study area.

In order to allocate the county-wide area source emissions into the 30 grids in the analysis area, the methodologies described in Volume 13 of the AQMA guidelines, Allocating Projected Emissions to Sub-County Areas,[10] were employed to develop apportioning factors for each source category. The parameters used for apportioning the area source emissions are summarized in Table 3.6; the resulting area source emissions by grid for the three analysis years are presented in Tables 3.7, 3.8, and 3.9.

For the projection years 1980 and 1985, it was assumed that the percentage of total traffic in a county within each

Table 3.3. POINT SOURCE EMISSIONS IN ANALYSIS AREA

Source name		Estimated emissions, ton/yr Partic	SO_2	NO_x
1974				
1.	Farmers Elevator & Mercantile	10	0	0
2.	Underwood Elevator	4	0	0
3.	Basin I	46	10,499	3,962
4.	MDU Boiler 1[a]	205	173	54
5.	MDU Boiler 2[a]	205	173	54
6.	MDU Boiler 3[a]	205	173	54
7.	MDU Boiler 4[a]	218	346	108
8.	MDU Boiler 5[a]	218	346	108
9.	United Power, Stanton	3,822	8,448	2,682
10.	Beulah Farmers Elevator	4	0	0
11.	Beulah PV Elevator	10	0	0
12.	Hazen Farmers Elevator	17	0	0
13.	Minnkota Power	5,740	17,863	5,128
New, by 1980				
14.	Basin II	1,638	19,659	11,466
15.	Minnkota Unit 2	1,638	19,659	11,466
16.	United Power, Underwood	3,537	42,446	24,759
New, by 1985				
17.	MDU Beulah 1	1,638	19,659	11,466
18.	MDU Beulah 2	1,638	19,659	11,466
19.	Basin III	1,713	20,553	11,991
20.	Basin Beulah	3,276	39,318	22,932
21.	ANG Coal Gasification[b]	1,117	12,426	8,191
22.	ANG coal dust	219	0	0

[a] Electrostatic precipitator installed in 1975.

[b] Hydrocarbon emissions = 1093 ton/yr.

Table 3.4. AREA SOURCE PARTICULATE EMISSIONS FOR McLEAN-MERCER-OLIVER COUNTIES

Source category	Particulate emissions, ton/yr															
	McLean County				Mercer County				Oliver County				Dunn County			
	1974	1975	1980	1985	1974	1975	1980	1985	1974	1975	1980	1985	1974	1975	1980	1985
Fuel combustion:																
1. Lignite coal	63	62	56	51	130	127	115	104	53	52	47	42	64	63	57	51
2. Distillate oil	9	10	16	11	5	5	9	6	2	2	3	2	3	3	5	4
3. Residual oil	7	7	8	9	4	4	5	5	1	1	1	1	3	3	3	4
4. Natural gas	3	3	5	4	0	0	0	0	0	0	0	0	0	0	0	0
5. LPG	1	1	2	1	2	2	3	2	neg	neg	neg	neg	1	1	2	1
Burning:																
7. Open burning	5	5	5	5	neg	neg	neg	neg	5	5	5	5	11	11	11	11
Mobile sources:																
10. Highway vehicles	72	72	102	65	27	27	38	24	14	14	20	13	27	27	38	24
11. Off-highway	67	67	67	67	33	33	33	33	23	23	23	23	34	34	34	34
13. Railroads	4	5	7	10	1	1	2	2	1	1	2	2	1	1	2	2
Fugitive dust:																
16. Unpaved roads	39,610	39,610	39,610	39,610	16,180	16,180	16,180	16,180	10,240	10,240	10,240	10,240	19,770	19,770	19,770	19,770
17. Agriculture	4,679	4,679	4,679	4,679	3,439	3,439	3,439	3,439	2,551	2,551	2,551	2,551	4,221	4,221	4,221	4,221
18. Construction	39	171	0	0	96	0	835	96	96	160	0	0	0	0	643	0
19. Mining	0	0	0	1,725	1,587	1,587	4,904	5,635	437	437	1,256	1,256	0	0	0	2,300
20. Paved roads	267	284	597	406	96	102	220	149	45	49	110	73	86	92	180	139
Total	44,826	44,976	45,154	46,643	21,600	21,507	25,783	25,675	13,468	13,535	14,258	14,208	24,221	24,226	24,966	26,561

Table 3.5. AREA SOURCE EMISSIONS OF SO_2, HYDROCARBONS, AND OXIDES OF NITROGEN FOR AQMA COUNTIES

	Pollutant emissions, ton/yr											
	SO_2				HC				NO_x			
County/Source category	1974	1975	1980	1985	1974	1975	1980	1985	1974	1975	1980	1985
McLean County:												
Lignite coal	39	38	34	31	3	3	3	2	16	16	14	13
Distillate oil	6	6	10	7	2	2	3	2	17	18	30	21
Residual oil	25	25	29	32	1	1	1	1	19	19	22	25
Natural gas	neg	neg	neg	neg	2	2	3	2	25	27	44	31
LPG	1	1	2	1	1	1	2	1	8	9	14	10
Open burning	neg	neg	neg	neg	9	9	9	9	2	2	2	2
Highway vehicles	32	33	59	43	1095	979	1312	563	736	770	1098	737
Off-highway vehicles	44	44	44	44	308	308	308	308	564	564	564	564
Railroads	10	12	18	24	17	20	31	41	66	78	119	160
Evaporative	0	0	0	0	96	101	162	105	0	0	0	0
Total	157	159	196	182	1534	1426	1834	1034	1453	1503	1907	1563
Mercer County:												
Lignite coal	81	79	71	65	5	5	5	4	32	31	28	25
Distillate oil	3	3	5	4	1	1	2	1	12	13	21	15
Residual oil	14	14	16	18	1	1	1	1	11	11	13	14
LPG	1	1	2	1	1	1	2	1	11	12	19	14
Open burning	neg	neg	neg	neg	1	1	1	1	neg	neg	neg	neg
Highway vehicles	12	13	22	16	413	369	495	212	277	290	413	277
Off-highway vehicles	22	22	22	22	153	153	153	153	281	281	281	281
Railroads	2	2	4	5	3	4	5	7	14	17	25	34
Evaporative	0	0	0	0	41	43	69	46	0	0	0	0
Total	135	134	142	131	619	578	733	426	638	655	800	660
Oliver County:												
Lignite coal	33	32	29	26	2	2	2	2	13	13	12	11
Distillate oil	1	1	2	1	neg	neg	neg	neg	8	9	14	10
Residual oil	5	5	6	6	neg	neg	neg	neg	3	3	3	4
LPG	neg	neg	neg	neg	neg	neg	neg	neg	3	3	5	4
Open burning	neg	neg	neg	neg	10	10	10	10	2	2	2	2
Highway vehicles	6	6	11	8	218	195	261	112	147	154	219	147
Off-highway vehicles	15	15	15	15	108	108	108	108	196	196	196	196
Railroads	2	2	4	5	3	4	5	7	11	13	20	27
Evaporative	0	0	0	0	19	20	33	22	0	0	0	0
Total	62	61	67	61	360	339	419	261	383	393	471	401
Dunn County:												
Lignite coal	40	39	35	32	3	3	3	2	16	16	14	13
Distillate oil	2	2	3	2	1	1	1	1	3	3	5	4
Residual oil	9	9	10	12	neg	neg	neg	neg	7	7	8	9
LPG	1	1	2	1	1	1	2	1	9	10	16	11
Open burning	1	1	1	1	20	20	20	20	4	4	4	4
Highway vehicles	12	13	22	16	417	373	500	214	216	226	322	216
Off-highway vehicles	23	23	23	23	160	160	160	160	290	290	290	290
Railroads	1	1	2	2	2	2	4	5	9	11	16	22
Evaporative	0	0	0	0	36	38	57	40	0	0	0	0
Total	89	89	98	89	640	598	647	443	554	567	675	569

Table 3.6. APPORTIONING FACTORS BY SOURCE CATEGORY

Source category	Apportioning factor	Source of apportioning data
Fuel combustion	dwelling units	county highway maps
Open burning	dwelling units	county highway maps
Highway vehicles	miles of road, both paved and unpaved	county highway maps
Off-highway	acres of cropland	county ASCS offices
Railroad	miles of track	county highway maps
Unpaved roads	miles of unpaved roads	county highway maps
Agriculture	acres of cropland	county ASCS offices
Construction	power plant sites	
Mining	location of major mining operations and acres mined	State Planning Division, Coal Impact Project Report, and mining companies
Paved roads	miles of paved roads	county highway maps

Table 3.7. PARTICULATE EMISSIONS BY GRID AND SOURCE CATEGORY, 1974

Grid	Source category, ton/yr										
	Fuel combustion	Open burning	Highway vehicles	Off-highway	Railroads	Unpaved roads	Agriculture	Construction	Mining	Paved roads	Total
1	2		1	2		777	159				941
2	2		2	2		1066	257			neg	1329
3	3		1	3		904	317				1228
4	2	neg	1	2		686	176				867
5	neg	neg	1	1		764	91			neg	857
6	6	neg	2	1	neg	838	90	171		8	1116
7	2		1	2	neg	494	159			9	667
8	2		1	1	neg	635	151			10	800
9	33		1	3	neg	565	317			10	929
10	14		1	3	neg	649	317			13	997
11	1	neg	1	1	neg	623	53				679
12	1	neg	2	1		925	86				1015
13	34		1	1	neg	445	119		397	6	1003
14	5	neg	1	2	neg	562	237		99	3	909
15	3	neg	1	1	neg	749	139				893
16	2	neg	1	1		675	72			5	756
17	2	neg	1	1	neg	281	59	96	1090	12	1542
18	1	neg	1	1	neg	436	86				525
19	2		1	1		529	89			6	628
20	3	neg	1	1		707	153				865
21	3	neg	1	1		661	153				819
22	3	neg	1	1		621	153			5	784
23	15	1	1	1		519	131			5	673
24	1	neg	1	1		501	114				618
25	2		1	2		614	127			6	752
26	2	neg	1	1		729	153				886
27	2	neg	1	1		501	153				658
28	3	neg	1	1		527	153			6	691
29	6	1	1	1		593	134		437	5	1178
30	2	neg	1	1		427	111	96		8	646

Table 3.8. PARTICULATE EMISSIONS BY GRID AND SOURCE CATEGORY, 1980

Grid	Source category, ton/yr										
	Fuel combustion	Open burning	Highway vehicles	Off-highway	Railroads	Unpaved roads	Agriculture	Construction	Mining	Paved roads	Total
1	2		2	2		777	159				942
2	2		2	2		1066	257			1	1330
3	2		2	3		904	317				1228
4	2	neg	1	2		686	176				867
5	neg	neg	2	1		764	91			1	859
6	7	neg	2	1	neg	838	90			18	956
7	2		1	2	neg	494	159	643	2300	20	3621
8	2		2	1	neg	635	151			23	814
9	31		2	3	neg	565	317			23	941
10	13		2	3	neg	649	317			31	1015
11	1	neg	1	1	neg	623	53				679
12	1	neg	2	1		925	86				1015
13	32		1	1	neg	445	119	96	834	13	1541
14	5	neg	1	2	neg	562	237		390	6	1203
15	2	neg	1	1	neg	749	139				892
16	2	neg	1	1		675	72			13	764
17	2	neg	1	1	neg	281	59	96	1380	27	1847
18	1	neg	1	1	neg	436	86				525
19	2		1	1		529	89			13	635
20	3	neg	1	1		707	153				865
21	2	neg	1	1		661	153				818
22	3	neg	1	1		621	153			13	792
23	14	1	1	1		519	131			18	685
24	1	neg	1	1		501	114				618
25	2		2	1		614	127			13	759
26	2	neg	1	1		729	153				886
27	2	neg	1	1		501	153				658
28	3	neg	1	1		527	153			16	701
29	5	1	1	1		593	134		1256	12	2003
30	2	neg	1	1		427	111			19	561

Table 3.9. PARTICULATE EMISSIONS BY GRID AND SOURCE CATEGORY, 1985

Grid	Source category, ton/yr: Fuel combustion	Open burning	Highway vehicles	Off-highway	Railroads	Unpaved roads	Agriculture	Construction	Mining	Paved roads	Total
1	2		1	2		777	159				941
2	2		1	2		1066	257			1	1329
3	2		1	3		904	317				1227
4	2	neg	1	2		686	176				867
5	neg	neg	1	1		764	91			1	858
6	6	neg	1	1	neg	838	90		1725	12	2673
7	1		1	1	neg	494	159		2300	14	2970
8	2		1	1	neg	635	151			15	805
9	28		1	3	neg	565	317			15	929
10	12		1	3	neg	649	317			21	1003
11	neg	neg	1	1	neg	623	53				678
12	1	neg	1	1		925	86				1014
13	28		1	1	neg	445	119	96	1272	9	1971
14	4	neg	neg	2	neg	562	237		683	4	1492
15	2	neg	1	1	neg	749	139				892
16	2	neg	1	1		675	72			8	759
17	2	neg	1	1	neg	281	59		1380	18	1742
18	1	neg	1	1	neg	436	86				525
19	2		1	1		529	89			9	631
20	2	neg	1	1		707	153				864
21	2	neg	1	1		661	153				818
22	2	neg	1	1		621	153			9	787
23	12	1	1	1		519	131			8	673
24	1	neg	neg	1		501	114				617
25	2		1	1		614	127			9	754
26	1	neg	1	1		729	153				885
27	2	neg	1	1		501	153				658
28	3	neg	1	1		527	153			10	695
29	5	1	1	1		593	134		1256	8	1999
30	2	neg	1	1		427	111			12	554

grid would remain the same as in 1974, or that the additional traffic due to growth would not be concentrated in a few grids. Data on new and upgraded roads were obtained from the State Highway Department. Projections of new housing units by grid (actually by town) were obtained from the same reference as the population projections used in the area source inventory, Social Impacts of Six Coal Conversion Plants,[3] prepared by the State Division of Planning. Locations of new coal mining sites were determined from the Coal Impact Study and contacts with the mining companies.

Meteorology

The primary meteorological input data for CDM--the joint frequency distribution of six wind speed classes, 16 wind directions, and six stability classes in the format of the day-night STAR program--was available from the Bismarck National Weather Service Station for the five year period 1967-1971 (eight observations/day). The Bismarck weather station is about 25 miles south of the edge of the analysis area. The environmental impact study for the ANG coal gasification plant included short-term meteorological data collection from a site just north of Beulah; analysis of this data[9] indicated that wind speeds and directions at Beulah and Bismarck were almost the same except for slightly higher average wind speeds recorded at Beulah. No differences would be anticipated within these distances in an area of the Great Plains lacking sharp terrain features.

Additional wind speed and direction data were collected in or near the analysis area as part of the Northern Great Plains Resource Program. Two of the NGP sites were located at Stanton in Mercer County and McClusky in Sheridan County. At the time that the AQMA analysis began, only a few months of data were available from these sites for comparison with

the Bismarck readings. Linear regression analysis of three-hour average wind speed and direction readings for each of the NGP sites and the Bismarck station showed only fair correlations:

NGP site	Correlation coefficient, comparison with Bismarck data	
	Wind speed	Wind direction
Stanton	0.67	0.76
McClusky	0.52	0.67

However, many problems were experienced initially with the meteorological equipment at these NGP sites, and the correlation is attributed to instrumentation problems rather than to different wind patterns at these nearby locations.

After reviewing all available wind speed and direction data, it was determined that the data from Bismarck in the day-night STAR format would be representative of the analysis area.

The other meteorological data required for input to CDM--mean annual nocturnal and afternoon mixing heights--were also obtained from the Bismarck weather station, where the only routine upper air measurements in the state are made. The mean nocturnal mixing height is 359 m; the mean afternoon mixing height is 1448 m.

For the short-term model, conditions simulating the most stable atmospheric conditions and a low mixing height (low level inversion) were specified. The other two atmospheric conditions often associated with short-term peak concentrations--plume looping (unstable atmosphere) and plume trapping aloft followed by breakup of stable conditions--are not appropirate for time periods of 24 hours. Therefore, the following meteorological input data were used:

Wind direction = 240°

Wind speed = 2.0 m/sec daytime
1.0 m/sec nighttime

Stability = D for daytime
E for nighttime

Mixing height = 800 m maximum
500 m minimum

Temperatures = diurnal variation in
40's and 50's

Receptor Locations

Receptor locations for prediction of ground-level concentrations in the CDM model can be specified at any points in the analysis area. In order to assure complete coverage of the area, a rectangular array of receptors at the corners and center of every area source grid was specified, as shown in Figure 3.3. In addition, four other receptors were located at the UTM coordinates of the four sampling sites in the area so that predicted and measured concentrations could be compared. This design resulted in a total of 76 receptors spaced throughout the 50 by 60 km area.

Background Air Quality

Background concentration is that portion of measured ambient pollutant levels that cannot be reduced by controlling emissions from local man-made sources. For SO_2 and NO_x, background is usually considered to be negligible. For particulate, the non-reducible fraction may originate from long-range transport, natural sources such as windblown dust and biological debris, and atmospheric aerosol formation.

The method specified in the Federal regulations (Section 51.13c) for estimating particulate background is to use the concentration measured at a nonurban site in or near the

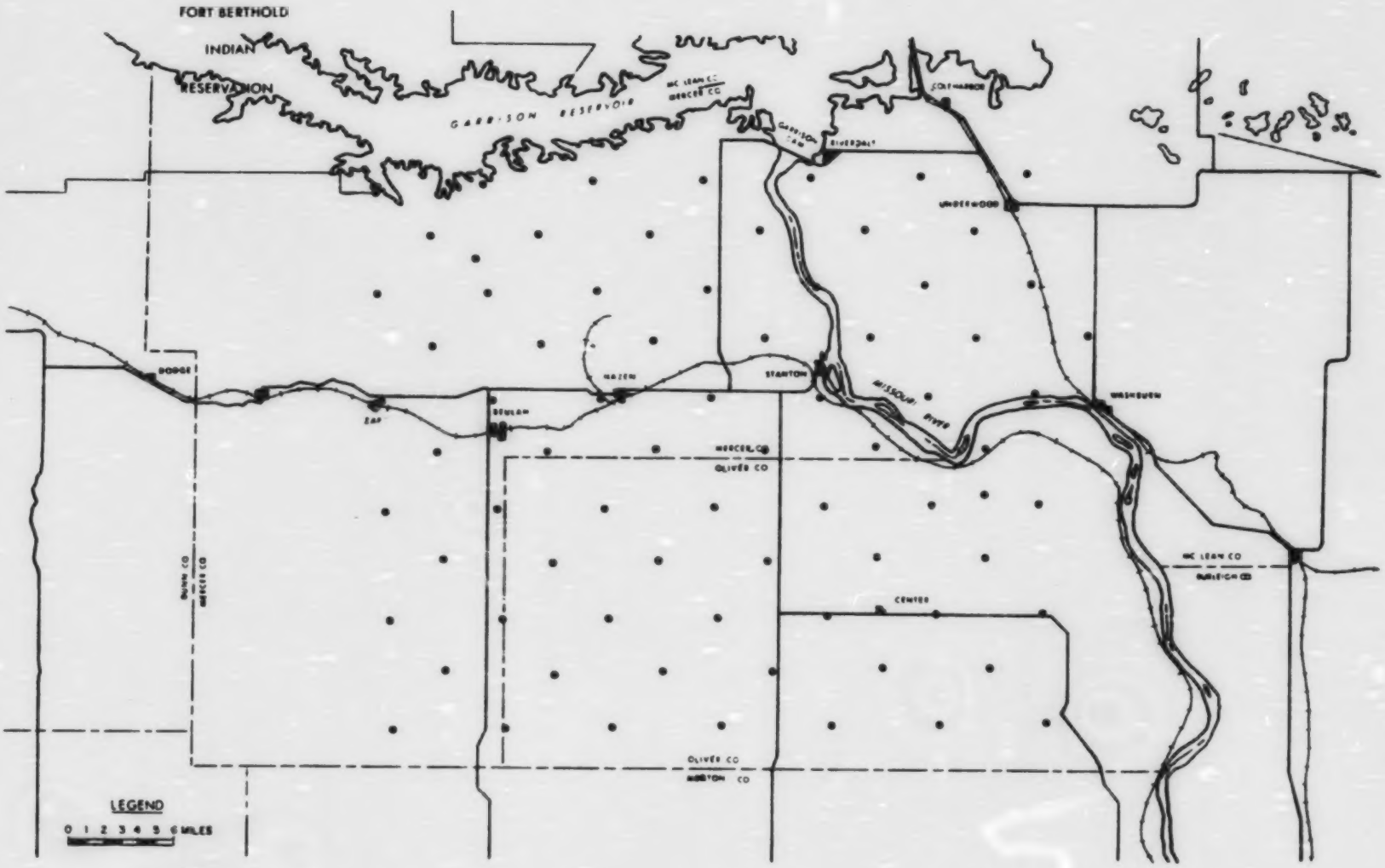

Figure 3.3. Receptor locations.

study area that is unaffected by nearby emission sources. All four of the high volume sampler sites in the AQMA would be characterized as nonurban. The one with the lowest annual geometric mean, the Beulah WET site at 20 ug/m^3 in 1974, also probably has the lowest surrounding source impact of the four sites. The site has the lowest concentration recorded in the state, and the values of 24 ug/m^3 arithmetic mean and 20 ug/m^3 geometric mean compare well with background concentrations determined for other areas in the northern Great Plains states. Therefore, the readings from this site were used for particulate background concentrations in the modeling.

BASE YEAR AIR QUALITY AND MODEL VERIFICATION

Even though the AQMA is sparsely populated, there is a relatively good network of sampling stations to provide measurements of baseline air quality: four particulate and SO_2 sites and two NO_x sites. The stations in the NGP study were installed during 1974, so annual averages for that calendar year are not available. However, a continuous year of data was generated (September 1974 through August 1975) which has been considered as base year in this analysis. All the sampling data for the three pollutants show concentrations to be just above background in the base year, and none of the measurements approach either the annual or short-term averages for primary or secondary air quality standards.

The CDM model was first run for the base year 1974 so that the modeling results could be verified by comparison with measured concentrations. The model predicts annual arithmetic concentrations at all specified receptor sites. The pollutant NO_x was not analyzed directly with the model, which only handles two pollutants per run. Instead, NO_x

concentrations were assumed to be proportional to predicted SO_2 concentrations at receptor sites since the point sources are the same and the two pollutants are emitted in a constant ratio by the point sources. Model-predicted values are compared with measured values in Table 3.10.

For particulate, the only pollutant for which quantitative data are sufficient to calibrate the model, linear regression between predicted and measured values yields a slope of 0.088 and a y-intercept of 30.0 for the line of best fit, and a correlation of 0.40. Ideally, the slope and correlation should approach 1.0 and the y-intercept should be near zero when background has been included in the predicted concentrations. However, a regression analysis for such closely spaced points is subject to large errors and is not really indicative of the close agreement between predicted and measured concentrations. Review of the data pairs shows that the model was within 8 ug/m^3 of the measured value in all four cases and that the ratio of predicted to measured values was 1.02.

There are some limitations on the accuracy of any model that would be inherent in the input data for this analysis area:

- The concentrations due to source emissions are much less than background, which was assumed to be constant throughout the analysis area. Small variations in actual background in different parts of the AQMA would have a strong influence on the total measured concentrations and on the resulting correlation between predicted and measured concentration.
- The majority of particulate emissions are from fugitive dust sources which, by their nature, are difficult to quantify or to locate accurately.

Table 3.10. COMPARISON OF MODEL-PREDICTED AND MEASURED POLLUTANT CONCENTRATIONS IN AQMA ANALYSIS AREA (ANNUAL AVERAGE)

Pollutant	Receptor site	Predicted ann. arith. mean, ug/m^3	Measured ann. arith. mean, ug/m^3
Partic	Beulah WET	32	24
	Beulah WP	35	35
	Stanton	33	39
	Washburn	32	35
SO_2	Beulah WET	1	neg
	Beulah WP	4	neg
	Stanton	4	bubbler = 14 contin. = neg
	Washburn	2	bubbler = 15 contin. = neg
NO_x	Stanton	1.3	bubbler = 3.5 contin. = neg
	Washburn	0.7	bubbler = 3.4

In view of the reasonable values obtained with the model even with the limitations cited above, the CDM model has been applied with a calibration factor of 1.0 to predict future particulate concentrations in the analysis area. For SO_2 and NO_x, the measured and predicted values are both so low that no assessment of the predictive capabilities of the model can be made. Therefore, the model will also be applied with no calibration correction for these two pollutants.

Prior to plotting the predicted particulate concentrations on a map of the analysis area, the values were converted from annual arithmetic to annual geometric means so that they could be compared directly with the applicable primary and secondary standards of 75 and 60 ug/m^3, respectively. This was accomplished by use of the following equation relating the two measures:

$$\frac{\text{arith. mean}}{\text{geom. mean}} = e^{1/2 \ln^2 SGD} \qquad \text{(eq.1)}$$

where SGD = standard geometric deviation

Standard geometric deviations of the four sampling data sets varied from 1.65 to 2.55. Since background is such a large portion of the predicted concentrations at all the receptors, the SGD of 1.86 from the site used as background was assumed to be representative for all locations. This represents a conservative assumption, as a higher SGD would produce lower geometric mean values. By solving equation 1 above for an SGD of 1.86, it can be determined that the geometric mean is 0.825 of the predicted arithmetic mean at a receptor.

The predicted particulate concentrations are shown in Figure 3.4. Concentrations are fairly uniform throughout the analysis area and, as indicated by the sampling data,

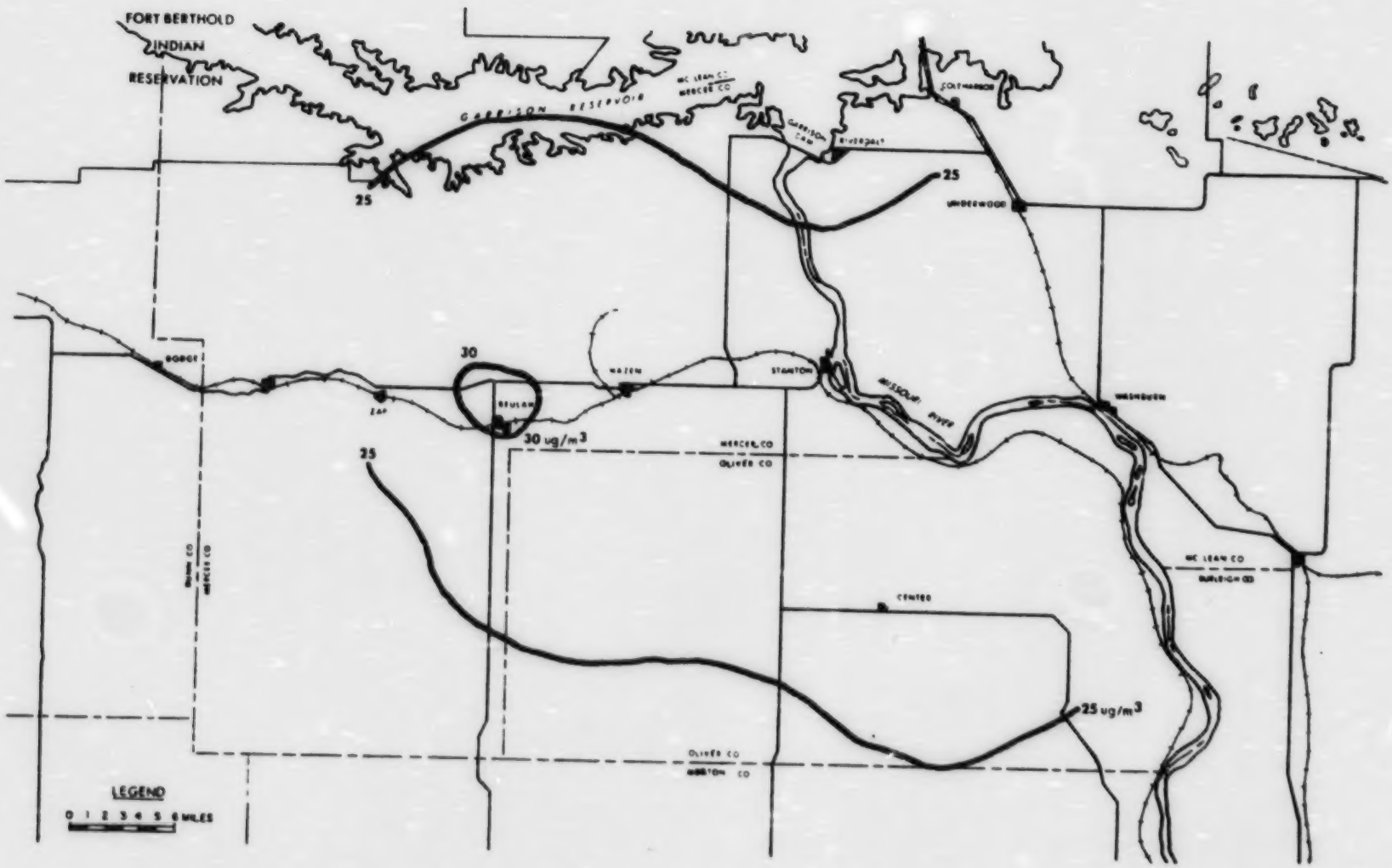

Figure 3.4. 1974 geometric mean particulate concentrations.

not much above background. No isopleth maps were prepared for SO_2 and NO_x concentrations because predicted concentrations were not substantially above zero for either pollutant in any part of the area. The highest predicted SO_2 level was four ug/m^3 compared to the standard 80 ug/m^3; the highest NO_x level was slightly above one ug/m^3 compared to the standard of 100 ug/m^3.

The short-term PDM model also predicted peak concentrations well above the standards throughout the analysis area. Model-predicted values are compared with measured maximum concentrations at sampling sites in Table 3.11. For particulates, the average ratio between predicted and measured 24-hour maximum values was 0.58; the ratio between predicted and second high measured values was 0.73. The highest predicted 24-hour concentration (uncorrected) at any receptor in the analysis area was 99 ug/m^3, including an estimated background of 24 ug/m^3. Thus, even considering the tendency of the model to underpredict, it does not appear that short-term particulate concentrations above the secondary standard are occurring. All predicted 24-hour SO_2 and NO_x concentrations were less than 50 and 20 ug/m^3, respectively.

PROJECTED AIR QUALITY

The models were reapplied to the area using projected emissions for 1980 and 1985, with other input data remaining the same. Thus, the model calculated expected arithmetic mean and maximum concentrations at receptor sites for 1980 and 1985. Particulate concentrations were converted to geometric mean values using the procedure described in the preceding section.

Figures 3.5 and 3.6 show isopleths of the predicted 1980 and 1985 particulate concentrations in the analysis

Table 3.11. COMPARISON OF MODEL-PREDICTED AND MEASURED POLLUTANT CONCENTRATIONS IN AQMA ANALYSIS AREA (SHORT-TERM PEAK)

Pollutant	Receptor site	Predicted max 24-hour, ug/m^3	Measured max 24-hour, ug/m^3	Second high 24-hour, ug/m^3
Partic	Beulah WET	45[a]	47	39
	Beulah WP	55	161	105
	Stanton	81	185	158
	Washburn	75	128	101
SO_2	Beulah WET	5	n.d.	n.d.
	Beulah WP	12	n.d.	n.d.
	Stanton	26	88	66
	Washburn	14	72	61
NO_x	Stanton	9	16	12
	Washburn	5	34	13

[a] Predicted particulate concentrations include a background of 24 ug/m^3.

n.d. = not detectable.

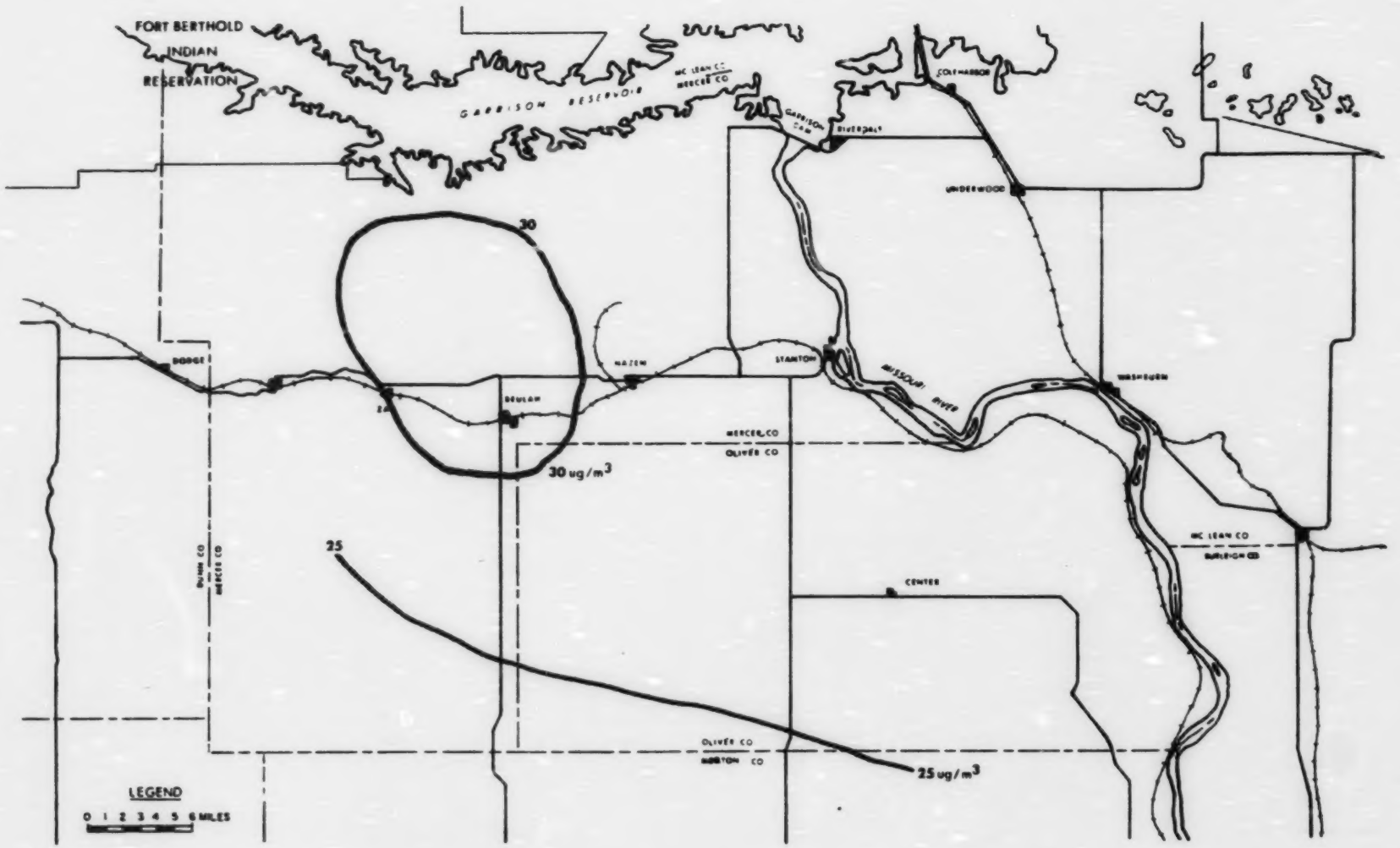

Figure 3.5. Predicted 1980 geometric mean particulate concentrations.

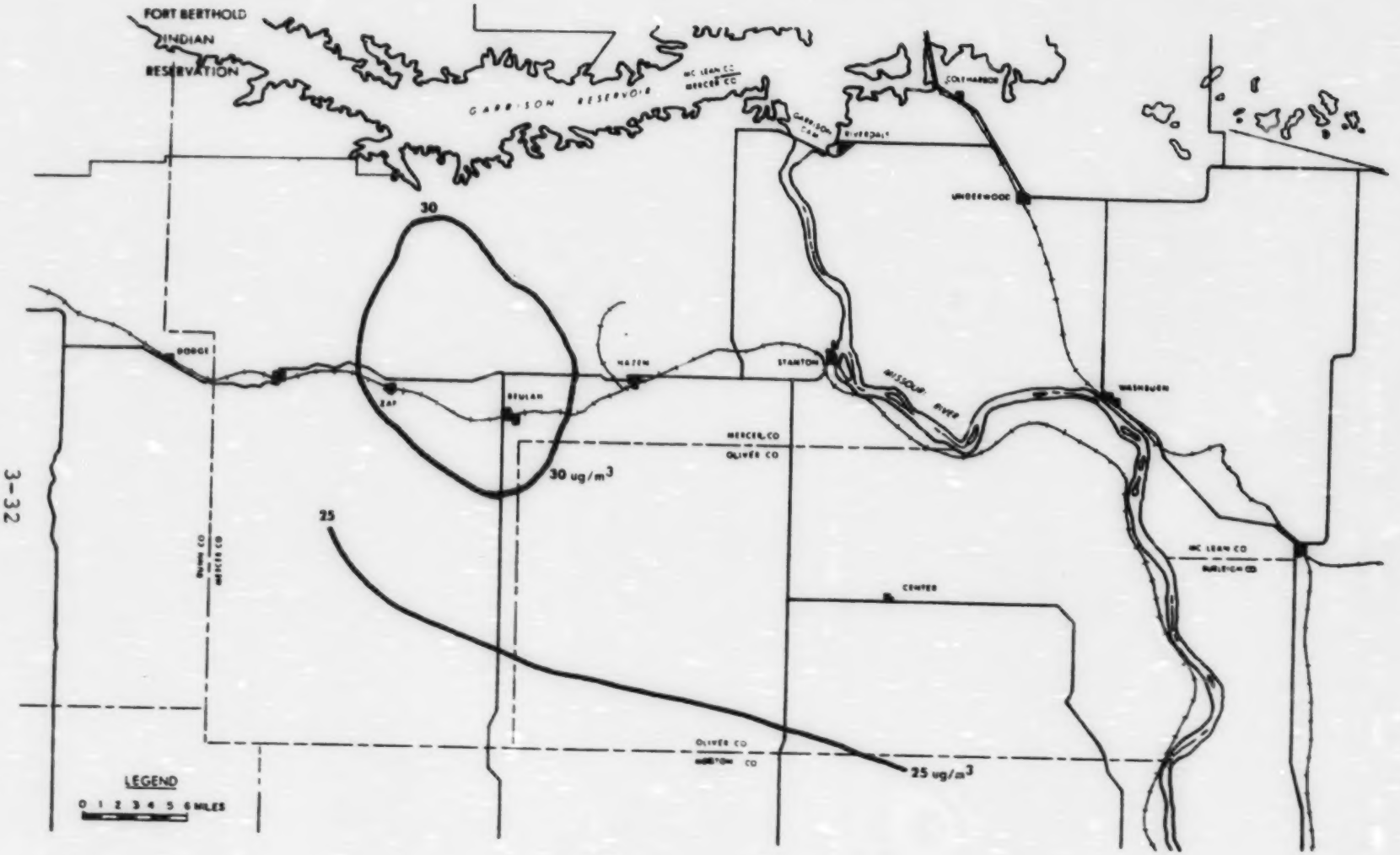

Figure 3.6. Predicted 1985 geometric mean particulate concentrations.

area. These concentrations in both years are slightly higher than for the base year, but still do not approach the levels of the secondary standard. The highest expected annual average concentrations in 1980 and 1985 were 32 ug/m^3.

The contributions of different source categories to ambient concentrations, as indicated by the CDM source contribution tables, are shown in Table 3.12. Obviously, undefined background sources are the major contributors at all receptors. Most of the remaining source impact is from area sources which contribute an even higher percentage than their portion of the emissions in the area because they are emitted at ground level and are uniformly distributed (near all receptors). By reviewing the area source emission data in Tables 3.7 through 3.9, it becomes apparent that most of the area source contribution is from unpaved roads and agriculture, but that most of the increase in particulate concentrations between the base year and the projection years is due to emissions from mining operations (unpaved road and agriculture emissions are estimated to remain constant in the projection years).

For SO_2 and NO_x, ground-level concentrations in the projection years do not increase nearly in proportion to the increase in emissions shown in Table 3.3. Maximum concentrations of SO_2 in the area are projected at 7 ug/m^3 in 1980 and 8 ug/m^3 in 1985, still only 10 percent of the annual standard. The 1985 distribution of ambient SO_2 concentrations throughout the analysis area is shown in Figure 3.7. Levels of NO_x are projected to increase to 2.3 ug/m^3 in 1980 and 2.7 ug/m^3 in 1985. Virtually all of the ambient SO_2 and NO_x concentrations are due to the major point sources.

Projected maximum concentrations follow trends similar to the annual averages. The maximum 24-hour particulate

Table 3.12. SOURCE CONTRIBUTIONS TO PREDICTED 1985 AMBIENT CONCENTRATIONS AT SELECTED RECEPTORS

Source	Percent of total ambient concentration contributed by each source		
	Near Beulah	Near Stanton	Near Center
Background	61	69	67
Point sources	3	2	5
Unpaved roads	11	15	15
Agriculture	3	3	4
Mining	21	10	8
All other area sources	1	1	1
Total	100	100	100

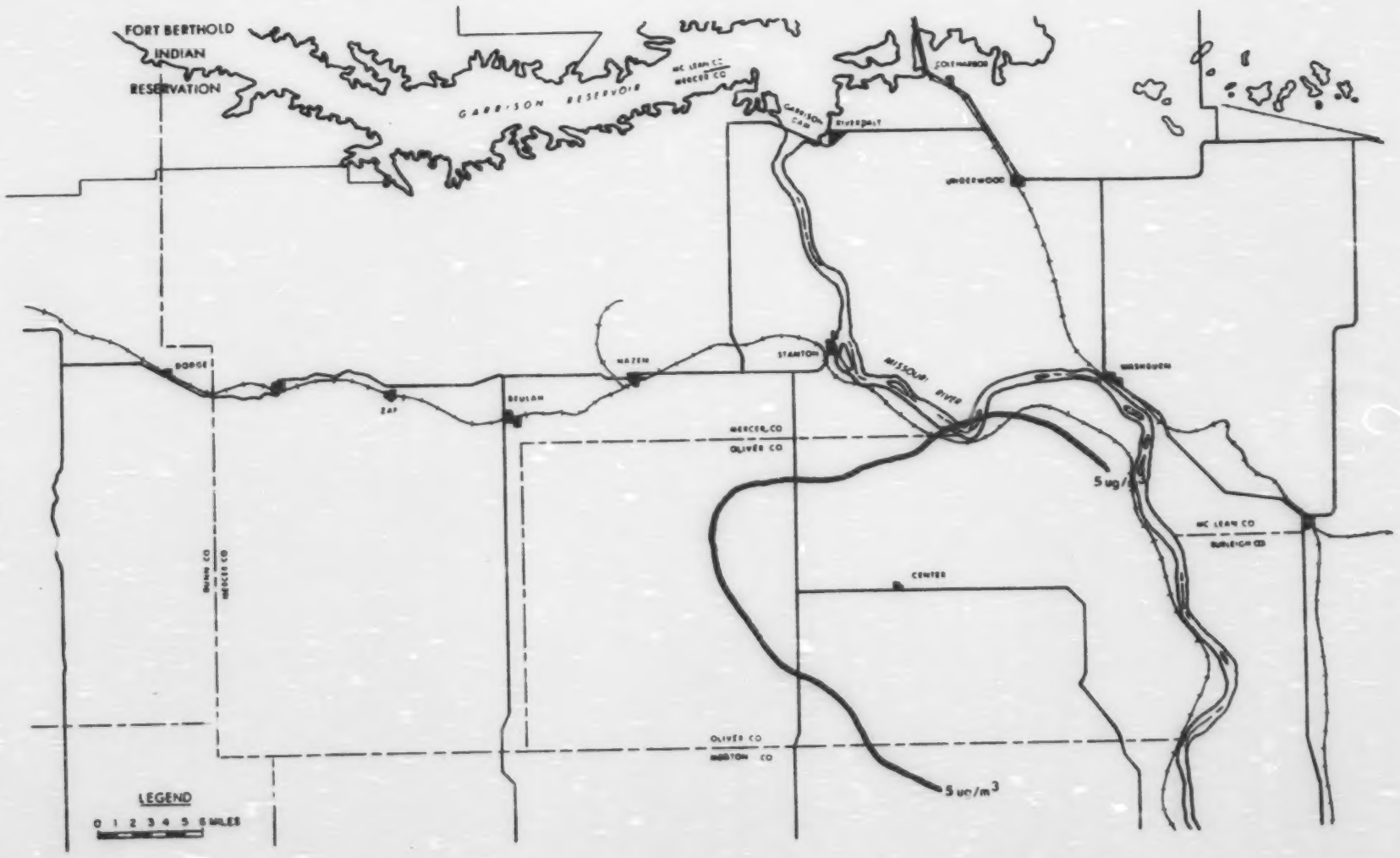

Figure 3.7. Predicted 1985 annual arithmetic mean SO_2 concentrations

concentrations in the analysis area (uncorrected) are predicted to increase from 99 ug/m^3 to 103 ug/m^3 in 1980 and 123 ug/m^3 in 1985. If these values are increased to compensate for underprediction by the model, second highest 24-hour concentrations would be approximately 141 ug/m^3 in 1980 and 168 ug/m^3 in 1985. Projected maximum 24-hour concentrations of SO_2 are still less than 100 ug/m^3 and projected maximum NO_x concentrations are less than 30 ug/m^3.

From the modeling results, it can be concluded that proposed developments during the next 10 years will not cause air quality standards for any of the three pollutants to be exceeded. Therefore, no maintenance plan should be required. Also, existing regulations for prevention of significant deterioration would be violated long before ambient levels of the particulate or SO_2 air quality standards were exceeded in this area and thus act as a maintenance measure in protecting air quality.

PHOTOCHEMICAL OXIDANT ANALYSIS

Existing concentrations of photochemical oxidant in the McLean-Mercer-Oliver AQMA have been measured at only one location, the proposed site of the ANG coal gasification plant north of Beulah. In a sampling period from July 2 through July 30, 1974, the peak one-hour measured concentration was 0.117 ppm and the second highest reading was 0.105 ppm, compared to the NAAQS of 0.08 ppm. Oxidant sampling was also performed at the proposed site for Natural Gas Pipeline's proposed coal gasification plant in Dunn County from September 1 through October 31, 1975, with the highest one-hour level being 0.035 ppm.[11] Since oxidant concentrations are closely related to solar intensity and temperature, peak concentrations usually occur during the summer months with longer daylight hours and higher temperatures.

Therefore, sampling during summer may have shown comparable levels to Beulah. The limited sampling data available indicates that the national standard is already being exceeded in the AQMA, even though very little of the potential development of the area has yet occurred.

Concentrations at or exceeding the standard have also been observed at many other rural and low-population density locations in the Rocky Mountain states (EPA Region VIII), as shown by the data summarized in Table 3.13. No extended sampling for oxidants has shown levels substantially below the standard, so it might be concluded from this data that naturally occurring background concentrations throughout this part of the country approximate the standard of 0.08 ppm.

Oxidants are not emitted directly into the atmosphere but are produced by a series of chemical reactions between organic compounds (including hydrocarbons) and nitrogen oxides in the presence of sunlight. Research has shown that the rate of oxidant formation is affected by the specific organic compounds present, the ratio of organic compounds to nitrogen oxides, and the meteorological conditions such as solar intensity, temperature, and atmospheric stability.

Generally, peak concentrations are measured within a few hours of noon, although the emissions of precursor compounds (organics and nitrogen oxides) contributing to these peak concentrations may occur several hours earlier or remain from the previous day. Since the atmospheric photochemical reactions usually take several hours, the measured oxidant concentrations may occur many miles downwind from the points of emission origin. This transport phenomenon has been demonstrated quite clearly by sampling data collected at urban and rural locations in Ohio and surrounding states in 1974.[12] The rural sites, all located within 75 miles of major metropolitan areas, had significantly higher

Table 3.13. OXIDANT SAMPLING DATA--SELECTED SITES IN EPA REGION VIII

Sampling site	Source of data	Peak one-hour		Date occurred	
		Highest	Next highest	Highest	Next highest
Beulah, ND	ANG Gasification Plant EIS	.117	.105	07/20/74	07/10/74
Dunn Center, ND	Natural Gas Pipeline Interim Report	.035[a]	.032[a]	09/14/75	09/08/75
Colstrip, MT	Colstrip Power Plant EIS	.080	--	06/74	--
Billings, MT	Yellowstone County Air Pollution Control Agency	.156	.152	07/04/75	07/11/75
Douglas, WY	Panhandle Eastern Gasification Plant EIS	.076	.075	06/21/74	06/21/74
Fort Collins, CO	PEDCo	.130	.127	10/18/75	09/09/75
Oil Shale Area, CO					
Tract A	Area Oil Shale Supervisor, Dept. of Interior	.089	--	Summer, 75	--
Tract B	Area Oil Shale Supervisor, Dept. of Interior	.080	--	06/26/75	--

[a] No sampling performed during summer months.

concentrations than the urban locations. Data from this study are shown in Table 3.14. Identifiable impacts on oxidant air quality have been shown to extend 50 to 75 miles from urban areas.[12] However, the only urban area near the AQMA is Bismarck-Mandan; its size and distance from the sampling sites would indicate only occasional impacts, certainly not with the frequency that the standard was violated at the Beulah site (18 out of 27 sampling days).

The probable sources of oxidant in this AQMA and other rural locations in Region VIII are: (1) downward transport from the ozone-rich layers in the stratosphere, due to strong vertical mixing, and (2) photochemical generation from organics emitted by vegetation. Ozone transport from the stratosphere may produce ground level concentrations as high as 0.03 to 0.05 ppm over extended periods and can cause even higher readings for one-hour peak periods under certain meteorological conditions.[12]

Other studies have shown that organic compounds emitted by vegetation may increase oxidants by as much as 0.02 to 0.05 ppm.[13] Normally, atmospheric conditions which would produce high concentrations from downward mixing from the upper atmosphere are not conducive to high oxidant generation rates from vegetation, and vice versa. However, the additive effect from these two sources gives values that support the hypothesis that measured concentrations of 0.08 ppm and higher in rural areas in the Great Plains are almost entirely due to natural sources of oxidant.

The Guidelines for Air Quality Maintenance Planning and Analysis[14] indicate that analyses for oxidants should be performed on a regional scale or AQMA-wide basis. Therefore, hydrocarbon emission densities from man-made sources for subcounty areas such as the area source grids or analysis area used in the CDM model were not estimated. County-wide emissions were assumed to represent a regional scale;

Table 3.14. OZONE DATA FOR OHIO, PENNSYLVANIA, AND MARYLAND

City	Maximum one-hour concentration,[a] ppm
Urban	
Cincinnati, OH	0.18
Dayton, OH	0.13
Columbus, OH	0.15
Canton, OH	0.14
Cleveland, OH	0.14
Pittsbugh, PA	0.15
Rural	
Wilmington, OH	0.18
McConnelsville, OH	0.16
Wooster, OH	0.17
McHenry, MD	0.17
Dubois, PA	0.20

[a] Occurred during June 14 to August 31, 1974.

Source: Control of Photochemical Oxidants--Technical Basis and Implications of Recent Findings. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. Publication Number EPA-450/2-75-005. July 1975.

emission densities were estimated for each of the four counties for the base year and projection years, as shown in Table 3.15.

The resulting emission densities are significantly lower than average urban hydrocarbon emission densities (100 to 1000 ton/mi^2/yr) reported to have an impact on measured peak oxidant concentrations.[12] Even though regional emission density in the AQMA is projected to increase approximately 230 percent by 1985, this density will still remain quite small as compared to an urban density.

From available air quality data and related research, it can be concluded that the NAAQS for oxidant will probably continue to be exceeded as a result of natural contributions alone. The increase in concentrations over background levels, that are the result of current and projected emissions of organic compounds from man-made sources in the AQMA, cannot be determined from available atmospheric dispersion models or the estimating procedure described in Appendix J to 40 CFR 51. An air quality maintenance plan would be unable to assure strict maintenance of the NAAQS for oxidants because of the impact of natural sources. However, it would still be prudent to minimize the effect of projected growth by requiring, through the mechanism of a maintenance plan, control of new hydrocarbon emission sources.

Table 3.13. COUNTY-WIDE HYDROCARBON EMISSION DENSITIES

Source category	Hydrocarbon emissions, ton/yr											
	McLean			Mercer			Oliver			Dunn		
	1974	1980	1985	1974	1980	1985	1974	1980	1985	1974	1980	1985
Point sources	0	2721	2721	1170	2367	8500	851	2111	2111	0	0	1093
Fuel combustion & open burning	18	21	17	9	11	8	12	12	12	25	26	24
Highway vehicles	1095	1312	563	413	495	212	218	261	112	417	500	214
Off-highway vehicles	308	308	308	153	153	153	108	108	108	160	160	160
Railroads	17	31	41	3	5	7	3	5	7	2	4	5
Evaporative	96	162	105	41	69	46	19	33	22	36	57	40
Total	1534	4555	3755	1789	3100	8926	1211	2530	2372	640	747	1536
Area of county, mi^2	2065			1042			721			1992		
Emission density, $ton/mi^2/yr$	0.7	2.2	1.8	1.7	3.0	8.6	1.7	3.5	3.3	0.3	0.4	0.8

4. CASS COUNTY AQMA

ANALYSIS AREA

Fargo, the largest city in North Dakota with a population of 56,000,[15] is located in Cass County. Together with West Fargo (pop. 6,500), the two cities account for almost 80 percent of the county's population. The urban area also includes Moorhead, Minnesota, located immediately adjacent to Fargo. Moorhead has a population of about 30,000. Cass County and Clay County (containing Moorhead) are designated as a Standard Metropolitan Statistical Area (SMSA). The two-county bistate area also comprises the planning boundaries for the Fargo-Moorhead Metropolitan Council of Governments. However, the Minnesota portion of the urban area was not designated as part of the AQMA. Limitation of the AQMA to Cass County makes determination of an analysis area much more difficult.

More than 98 percent of the 1750 sq mi area of Cass County is in farmland, either as row crop or pasture. In recent years, the amount of land in crops has been increasing at the expense of pasture land and summer fallow. Although urban sprawl has been identified as a potential problem by the Council of Governments,[16] it certainly would not change the percentage of land area in farmland significantly within the next 10 or 20 years. The particulate emission sources in Cass County are primarily agriculture related, such as grain storage, milling, drying, bulk fertilizer handling, wind erosion of cropland, and traffic on unpaved farm roads.

Existing (1974) particulate concentrations at all sampling sites in the two counties are less than the annual secondary standard, with the exception of the Fargo industrial site which had a geometric mean of 62 ug/m^3 in 1974. Over the past several years, the three sites in Cass County have measured approximately the same concentrations each year--the rural site near background level, the commercial site at approximately 50 ug/m^3, and the industrial site in the sixties. A very slight long-term trend toward improved air quality is noted from the historical data. However, the data from all sampling locations have relatively high standard geometric deviations, and the 24-hour primary standard (260 ug/m^3 maximum) has been exceeded in most years at all three sites in Cass County and at sites in Clay County, Minnesota.

The terrain in the area is extremely flat. The Red River of the North forms the state boundary dividing Fargo and Moorhead, but there is no discernible river valley or flood plain. The river, which flows north toward Canada, has a slope of only about one ft per mi.

The Fargo area also has very high wind speeds. National Weather Bureau statistics for the past 10 years show Fargo to have the highest average wind speed of any U.S. city, 14.4 mph.[17] The winds combined with the flat terrain of the Red River valley cause severe wind erosion problems, which probably are the cause of the maximum particulate readings exceeding the short-term air quality standards.

The AQMA is an area of moderate population and economic growth. The estimated 1980 and 1985 populations of Fargo are 58,400 and 61,000, respectively.[18] Almost all the population growth in Cass County is expected to be in Fargo and West Fargo.[16]

For the same reasons as those discussed in Chapter 3, the analysis area cannot include all of Cass County.

Therefore, a smaller analysis area of approximately 30 km by 50 km has been specified, as shown in Figure 4.1. This area includes almost all of the county's population and point sources, plus the areas with potential for growth. Although Clay County is not part of the AQMA, point sources from the Moorhead area have also been added in the analysis because of their possible impact on ambient concentrations in Fargo. The uniform distribution of area sources in Cass County indicates that ambient concentrations in the portion of the county excluded from the analysis area should not be substantially different than concentrations in the rural portions of Cass County included in the modeling area.

METHODOLOGY

The AQMA analysis for suspended particulate in Cass County is based on the use of regional dispersion modeling to predict ambient concentrations throughout the analysis area. The same model as that employed in the McLean-Mercer-Oliver AQMA, the Climatological Dispersion Model, was used in this analysis, for essentially the same reasons as described in Chapter 3. However, only base year conditions were simulated in this AQMA because neither the total emissions nor percentage contributions by source category were shown to change significantly from the base year to the projection years, as shown by the emission inventory summary in Table 4.1. Modeling results would not be able to show any distinction between base year and projection year air quality.

Even though particulate concentrations are not expected to change in Cass County, the area was still modeled to determine whether sampling sites are located at points where maximum concentrations in the county would be recorded, or whether other areas might have higher concentrations that

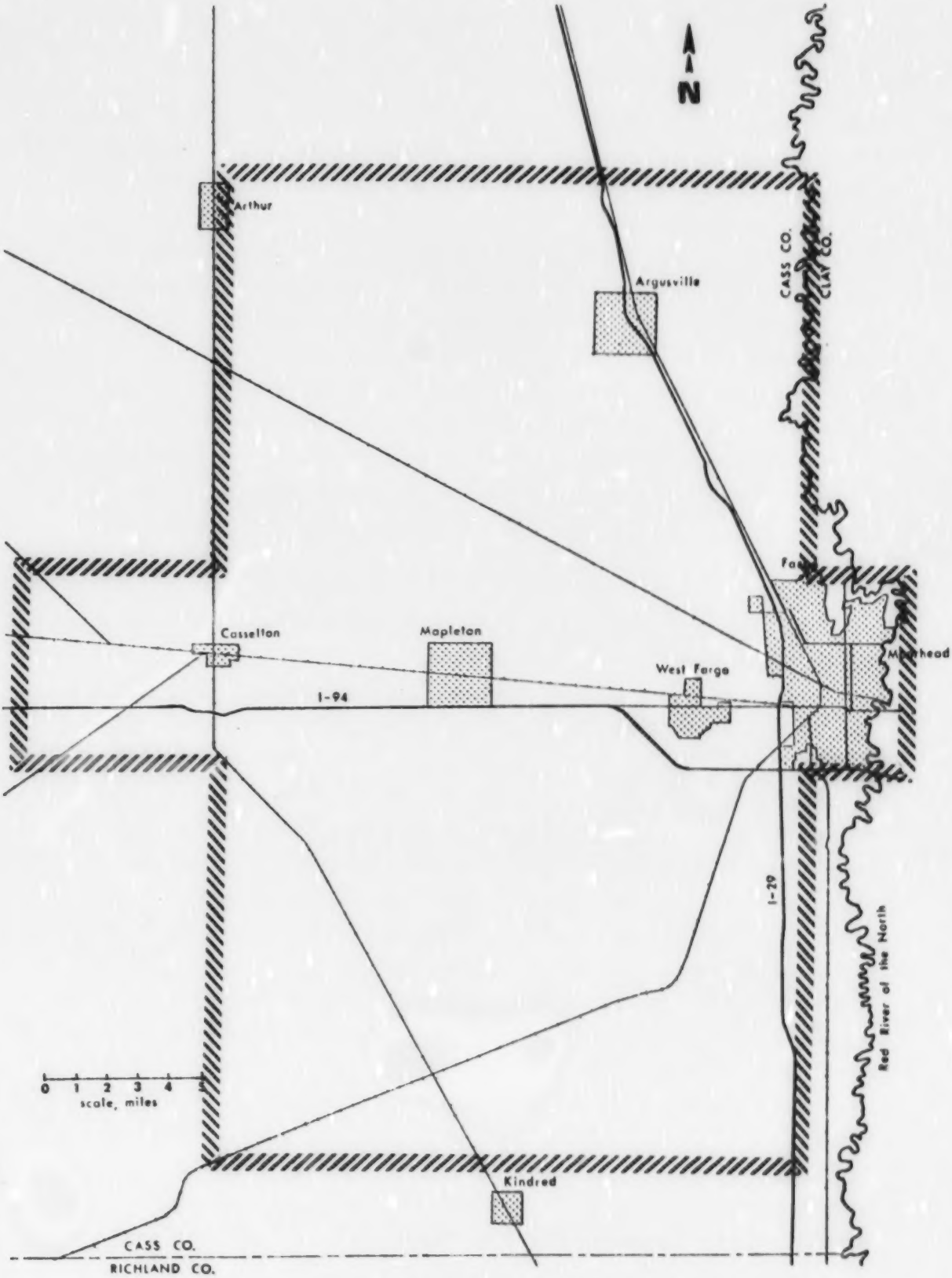

Figure 4.1. Cass County AQMA analysis area.

Table 4.1. PARTICULATE EMISSIONS FOR CASS COUNTY

Source category	Particulate emissions, ton/yr 1974	1975	1980	1985
Fuel combustion:				
Lignite coal	neg	neg	neg	neg
Distillate oil	109	110	114	119
Residual oil	92	92	113	131
Natural gas	11	11	12	14
LPG	3	3	3	3
Wood	2	2	2	2
Burning:				
Open burning	4	4	4	4
Incinerators	4	4	4	4
Agricultural burning	0	0	0	0
Mobile sources:				
Highway mobile sources	351	328	287	175
Off-highway vehicles	119	119	119	119
Aircraft	6	6	7	7
Railroads	34	40	61	82
Processes:				
Industrial processes	0	0	0	0
Portable batch plants	------not determined-------			
Fugitive dust:				
Unpaved roads	57,300	57,300	57,300	57,300
Agriculture	14,745	14,745	14,745	14,745
Construction	518	518	585	689
Mining	0	0	0	0
Paved roads	1,856	1,876	2,068	2,241
Point sources	1,189	1,190	1,109	1,134
Total	76,343	76,348	76,533	76,769

are exceeding the annual standards. In this case, a revision for attainment rather than a maintenance plan would be developed.

Data for the base year model were collected as described in the following sections.

Source Locations

The UTM coordinates for point sources were obtained from NEDS listings and checked by locating the sites on USGS quadrangle maps. The coordinates for each source are listed in the point source summary in Appendix A.

A grid system covering the analysis area was specified, as shown in Figure 4.2. The area source emissions for Cass County were apportioned into these 18 grids in order to distribute the emissions spatially for modeling.

Source Emission Rates and Stack Parameters

Point source emission data for the base year 1974 and stack parameters for these sources were obtained from file data in NEDS format, and are summarized in Appendix A. These data were input directly to the CDM model.

The point source emission projections shown in Table 4.1 were generated from the base year emission estimates and U.S. Department of Commerce OBERS projections of economic growth in the Fargo-Moorhead SMSA by industrial classification.[19] These national projections were used due to lack of any locally generated estimates of increases in manufacturing activity or employment.

With two exceptions (Fargo Foundry and North Dakota State University), the point sources are all in the agriculture and food products industrial classification, which has projected growth as follows for future years:

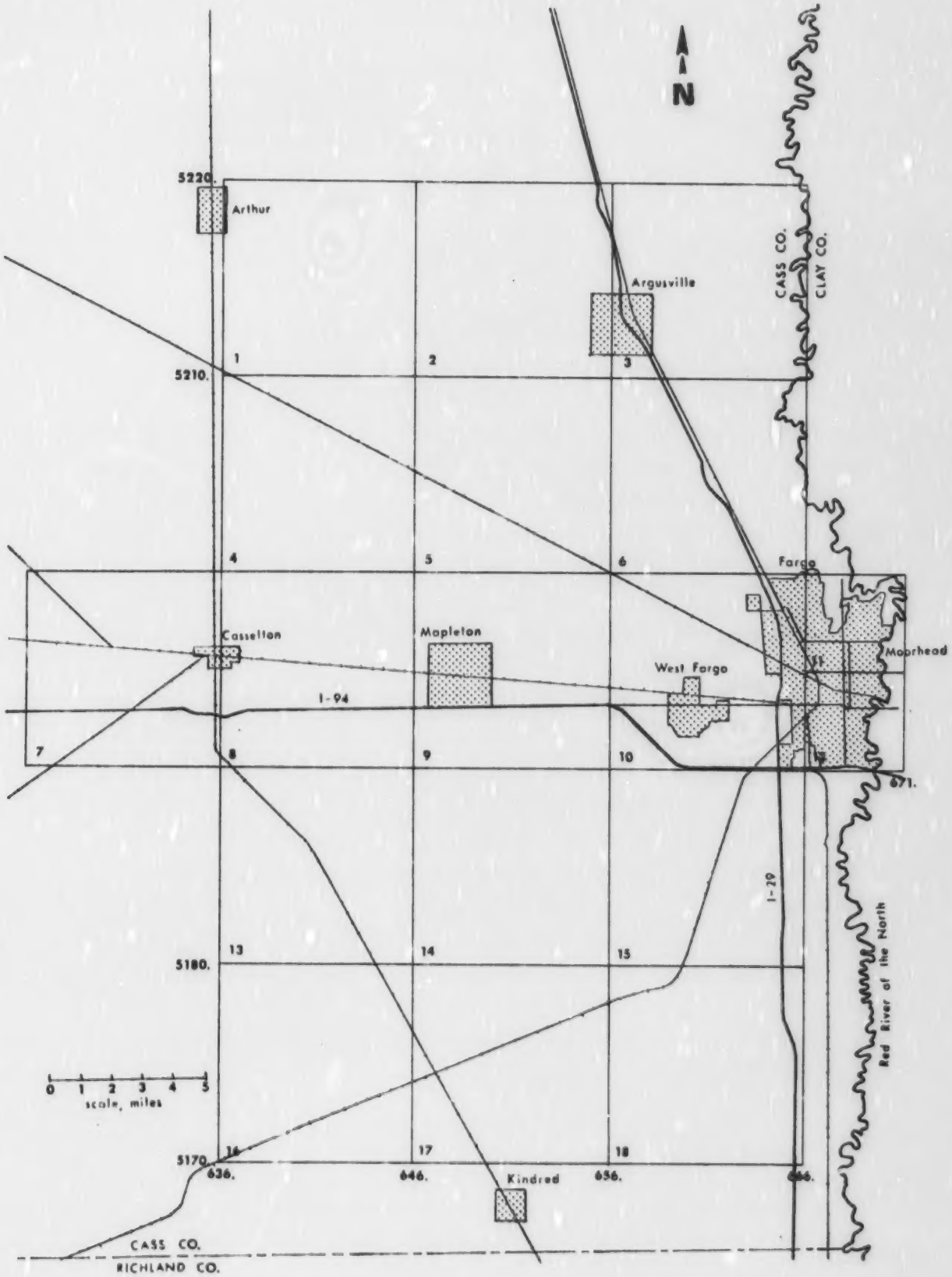

Figure 4.2. Area source grids for Cass County.

Year	Food industry earnings compared to 1974	Metals industry earnings compared to 1974
1975	1.00	1.05
1980	1.01	1.31
1985	1.03	1.64

Emissions for Fargo Foundry were increased according to projected earnings for the metals industry. Projected emissions for North Dakota State University for 1980 and 1985 were reduced by 80 percent from the 1974 level to account for control equipment scheduled for installation on the lignite-fired boilers. This projection methodology, described in Volume 7 of the AQMA guidelines,[20] probably overestimates future point source emissions because it does not account for the generally lower emission rates per unit production at the new or enlarged facilities providing the additional activity.

Area source emissions and projections by source category were obtained from the previously noted AQMA emission inventory report.[2] The emission estimates by source category from this report were summarized in Table 4.1. These emission totals for Cass County were allocated into the 18 area source grids by the same procedures used for the McLean-Mercer-Oliver AQMA (see table 3.6), except aircraft emissions were assigned to the grid containing the airport (no. 11) and construction emissions were divided uniformly among the three grids encompassing Fargo and West Fargo. The resulting area source emissions by grid are shown in Table 4.2.

Meteorology

Meteorological input data in the format of the day-night STAR program are available for the Fargo National

Table 4.2. CASS COUNTY EMISSIONS BY GRID AND SOURCE CATEGORY, 1974

Grid	Source category, ton/yr										
	Fuel combustion	Open burning	Highway vehicles	Off-highway	Railroads	Unpaved roads	Agriculture	Construction	Aircraft	Paved roads	Total
1	1	neg	7	3		1331	326			16	1684
2	neg	neg	8	3	neg	1208	323			43	1585
3	neg	neg	7	3	1	1293	317			28	1649
4	neg	neg	7	3	1	1379	326			6	1722
5	neg	neg	7	3	1	1293	326			20	1650
6	2	neg	8	2	1	1198	300			52	1563
7	1	neg	8	2	2	1227	304			40	1584
8	3	neg	8	2	1	1265	300			44	1623
9	1	neg	7	2	1	1132	292			49	1484
10	16	1	11	1	2	105	135	173		283	727
11	41	1	6		neg	48		173	6	149	424
12	123	3	13		1	76		173		338	727
13	neg	neg	8	3	2	1474	326			8	1821
14	neg	neg	7	3		1331	326			15	1682
15	1	neg	8	2	1	1436	309			35	1792
16	neg	neg	7	3	1	1474	326				1811
17	1	neg	7	3	1	1227	326			30	1595
18	1	neg	8	2	neg	1312	309			38	1670
Total	191	5	142	40	16	19809	4871	519	6	1194	26793

Weather Service Station for the five year period 1970-1974. The weather station is located at Hector Airport, within the city limits of Fargo. Based on the reliability of NWS data and central location of the station, this set of meteorological data has been used in the model.

Receptor Locations

Receptor locations in the CDM model were specified at the corners of the 10 km grids in the rural portions of Cass County and at 5 km intervals near the urban area, as shown in Figure 4.3. This configuration gave complete coverage of the area and concentrated the receptors in the areas where highest concentrations were anticipated. Also, receptors were designated at the locations of the four particulate sampling sites (three in Cass County, one in Moorhead) so that predicted and measured concentrations could be compared. This receptor array resulted in a total of 47 receptors spaced throughout the analysis area.

Background Air Quality

A background value for this AQMA was determined by the method specified in the Federal regulations (Section 51.13c) of using the concentration measured at a nonurban site in or near the AQMA that is unaffected by nearby emission sources. The rural Fargo site, located about four miles south of the city limits, was established as a background site, but has some source impact from the intensive farming in the area. In 1974, it recorded an annual geometric mean of 34 ug/m^3 and an arithmetic mean of 48 ug/m^3. Previous years' data showed similar concentrations.

Actual background for the area should be higher than in the McLean-Mercer-Oliver area (20 ug/m^3 geometric, 24 ug/m^3

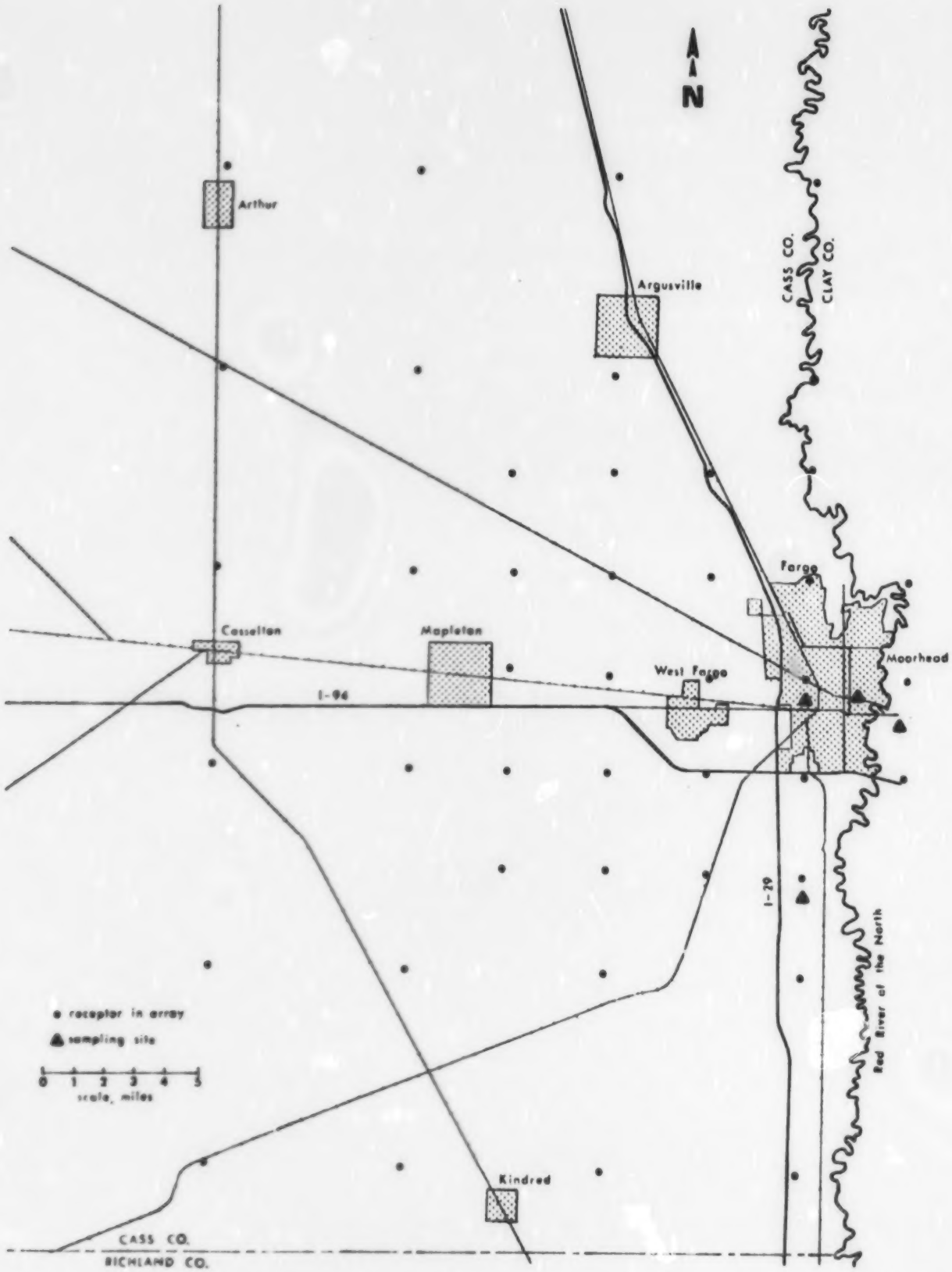

Figure 4.3. Receptor locations.

arithmetic) because of higher wind erosion potential, but probably somewhat lower than measured at the rural Fargo site. By subtracting the source impact indicated by the uncalibrated CDM model at the sampling site location, a better estimate of background would be obtained. This value for source impact was 4 ug/m^3, resulting in a corrected arithmetic background of 44 ug/m^3 and, using the SGD of 2.2 recorded for the site, a geometric mean background concentration of 32 ug/m^3. These are not much different than the uncorrected values, but the lower values have been used in the modeling.

PREDICTED AIR QUALITY AND MODEL VERIFICATION

The CDM model was run with the input data described above, and the modeling results were compared with measured particulate concentrations for purposes of verification. Linear regression analysis of predicted and measured values produced a slope of 1.236 and a y-intercept of 5.0 for the line of best fit, and a correlation of 0.49. The data sets are shown below:

Receptor	Predicted,[a] ug/m^3	Measured, ug/m^3
Fargo rural	48	48
Fargo industrial	59	82
Fargo commercial	52	56
Moorhead	61	52

[a] Includes background of 44 ug/m^3.

While this correlation was only fair and not high enough to use the model results as the sole basis for determining attainment or non-attainment, three of the four data sets showed reasonably good agreement. Also, it should be emphasized that the primary purpose of the modeling was to

determine whether there were other locations in the AQMA where concentrations might be higher than the measured values, possibly exceeding the secondary or even the primary annual standard. Even with the moderate correlation, the model should indicate if the sampling sites are in or near the points of highest concentration in the analysis area.

In order that the model-predicted values match the measured concentrations more closely, a calibration factor of 1.236 was applied to all predicted values. Also, the values were converted from annual arithmetic to annual geometric means by use of equation 1 on page 3-26, using an SGD of 2.2 from the Fargo rural and Fargo industrial sites. The ratio of geometric mean to arithmetic mean was calculated to be 0.733 for the SGD value of 2.2. Thus, model outputs for each receptor were converted to predicted concentrations by first multiplying by 1.236 for calibration, then adding 44 ug/m^3 to account for background, and finally multiplying by 0.733 to change the value to geometric mean.

The predicted particulate concentrations are shown in Figure 4.4. Concentrations are obviously highest in the immediate Fargo area and, at the scale of analysis employed, no points of expected higher concentration than the existing sites were determined.

It is interesting to note that on the basis of emissions in the county and in the analysis area (see Tables 4.1 and 4.2), unpaved roads and agriculture appear to be the major problem. However, these emissions are so evenly distributed throughout the analysis area that they add only a few ug/m^3 to concentrations; it is point source emissions and urban area source categories that contribute to the higher emission densities and ambient concentrations in the Fargo-Moorhead area. For example, the four receptors with highest predicted concentrations had 50 percent of their concentrations above background resulting from point source

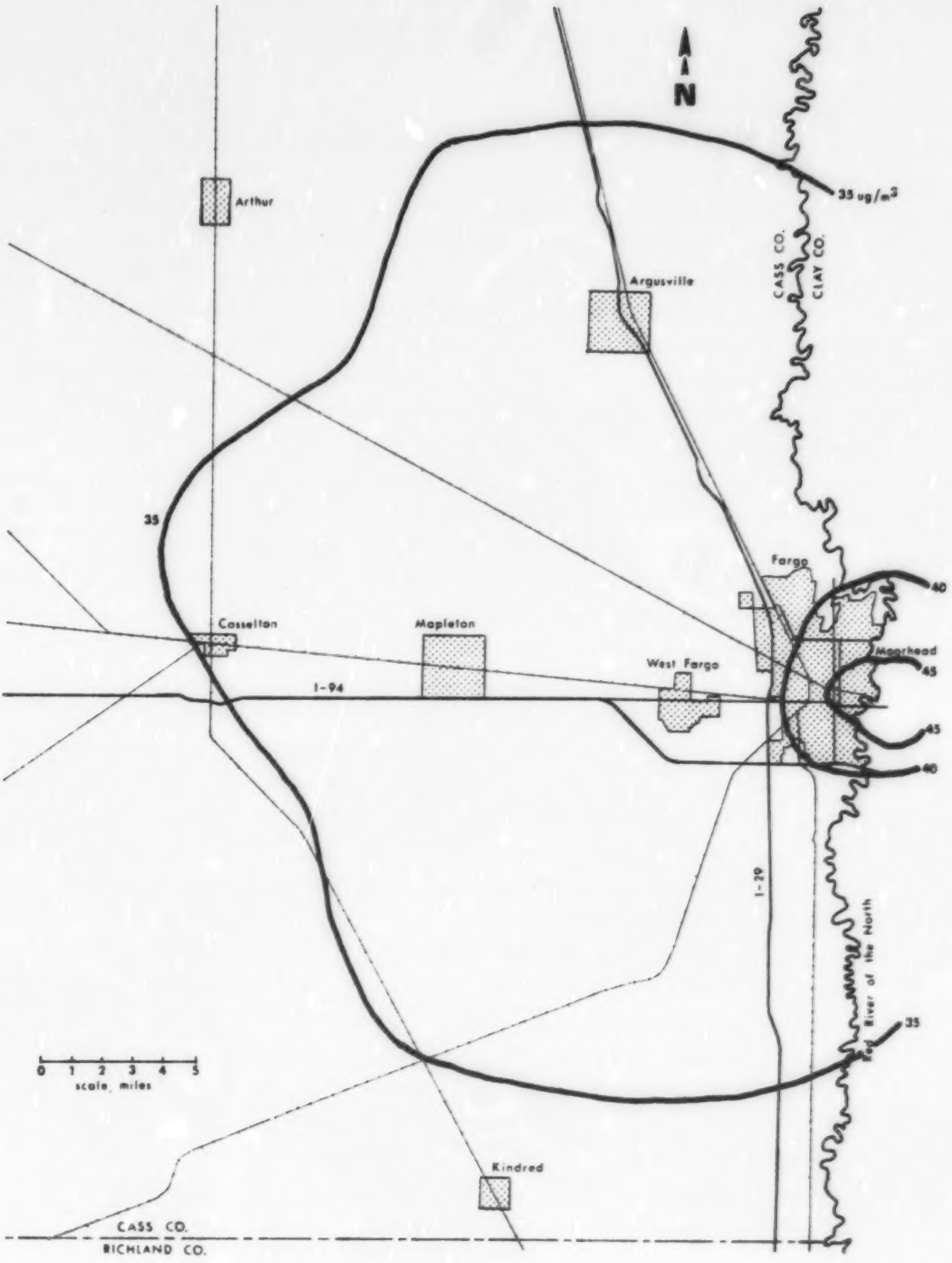

Figure 4.4. 1974 geometric mean particulate concentrations in Cass County AQMA.

emissions. Area source emissions for the urban grids in which these receptors were located showed that only about five to 10 percent of the total contribution at these receptors was from unpaved roads and agriculture; reentrained dust from paved streets, fuel combustion, and construction had greater impacts than the former two source categories.

Although the modeling does not show any violations of the annual air quality standards, either primary or secondary,[a] the short-term standards are probably exceeded throughout the AQMA. Since no change in emissions is anticipated over the next 10 years in Cass County, the 24-hour standards will probably continue to be exceeded. In 1974, the primary standard of 260 ug/m^3 was violated on two sampling days and the secondary standard of 150 ug/m^3 was exceeded on one additional occasion at the rural Fargo (background) site. In comparison, the primary standard was not exceeded and the secondary standard was exceeded only once at both the Fargo commercial and Moorhead sites. Two violations of the primary standard and eight additional violations of the secondary standard were recorded at the Fargo industrial site. Therefore, it can be concluded that the infrequent high concentrations are in most cases due to some uncontrollable fugitive dust source, either agriculture-related or from long-range transport. Since maintenance measures would not be effective in reducing these occasional high concentrations, it is concluded that no maintenance plan is required in the Cass County AQMA.

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[a] The 1974 measured geometric mean at the Fargo industrial site was 62 ug/m^3, a marginal violation of the secondary standard.

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APPENDIX A

NORTH DAKOTA AQMA POINT SOURCE SUMMARY

I.D. NUMBER ST CO AQ PLT PT YR	PLANT/POINT NAME	UTM COORD,KM HORIZ	UTM COORD,KM VERT	STACK DATA HT. (FT)	STACK DATA DIA (FT)	STACK DATA TEMP (F)	STACK DATA FLOW (ACFM)	STACK DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	SO2	NOX	HC	CO	ALLOWABLE EMISS,TPY PART	SO2
C00C	COUNTY CODES-NORTH DAKOTA	.	.		.										
C22C	CASS COUNTY	.	.		.										
C34C	DUNN COUNTY	.	.		.										
C72C	MC LEAN COUNTY	.	.		.										
C76C	MERCER COUNTY	.	.		.										
C86C	OLIVER COUNTY	.	.		.										
350220130C000 00		.	.		.										
350220130C000 01	CASS COUNTY POINT SOURCES	.	.		.										
350220130C000 02		.	.		.										
350220130C001 01 70	NORTHERN STATES PWR/BOILE	670.0	5194.0		.			0	123	96	35	2	5	26	97
350220130C001 02 70	BOILE	670.0	5194.0		.				24	230	83	6	11	62	231
350220130C001 03 70	BOILE	670.0	5194.0						96	161	58	4	8	43	162
350220130C001 04 70	BOILE	670.						0	206	161	58	4	8	43	162
350220130C001 05 70	BOILE							0	52	504	101	12	24	135	506
350220130C001 06 70	BOILE		.0		.			0	52	504	101	12	24	135	506
350220130C002 01 74	GRANDIN CARGILL,INC/SHIPI	650.0	5230.0	0	.0	77	0	20E	41	0	0	0	0	73	0
350220130C002 02 74	CLEANI	650.0	5230.0	20E	.	77		0	0	0	0	0	0	0	0
350220130C002 03 74	BULK FERTILIZ	650.0	5230.0	0	.0	77	0	20E	1	0	0	0	0	2	0
350220130C003 01 70	FARGO FOUNDRY/G.IRON CUPO	669.0	5194.0	100E	5.0E	600E	V=10fps		12	0	0	0	101	3	0
350220130C005 01 74	N.DAK.STATE UNIV./BOILER	668.0	5195.0	175	8.0	425	9363	0	21	28	6	1	2	39	229
350220130C005 02 74	BOILER	668.0	5195.0	175	8.0	425	9364	0	45	60	13	2	4	58	115
350220130C005 03 74	BOILER	668.0	5195.0	175	8.0	425	6688	0	2	3	1	0	0	12	20
350220130C005 04 74	BOILER	668.0	5195.0	175	8.0		28200	0	39	51	11	2	4	91	609
350220130C006 01 70	CASS-CLAY CREAMERY/BOILER	665.0	5194.0	800E	3.0E	400E	V=4fps	0	12	0	120	27	0	548	2055
350220130C007 01 70	BORDER STATES PAVING/ETHE	.	.		.				0					20	
350220130C007 02 70	ROTARY DRY	.	.						5					20	
350220130C011 01 70	NoIMPRV.ASPHALT 1/ACT.DRY								103					32	
350220130C011 02 70	OTHER				.				1150					32	

PLANT SUSPENDED OPERATION

PORTABLE

ST	CO	AQ	PLT	PT	YR	PLANT/POINT NAME	UTM COORD,KM HORIZ	UTM COORD,KM VERT	STACK HT. (FT)	STACK DIA (FT)	STACK TEMP (F)	DATA FLOW (ACFM)	DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	SO2	NOX	HC	CO	ALLOWABLE EMISS,TPY PART	SO2
35	022	C1	3600	11	03	70 BOILER							0	4	27	10		0	20	77
35	022	C1	3600	12	01	70 N.IMPRV.ASPHALT 1/P								145					210	
35	022	C1	3600	12	02	70								415			0	0	11	0
35	022	C1	3600	13	01	70 N.IMP										0	0	0	51	0
35	022	C1	3600	13	02	7									0	0	0	0	51	0
35	022	C1	3600			OPEN STORA								4	0	0	0	0	51	0
35	022	C1	3											70					105	
35	022	C1	3600	03	70	OTHER								20					3	
35	022	C1	300	15	01	74 GARDNER FARM.EL/SHIP&HAND	654.0	5223.0	0	.0	77	0	20E	7	0	0	0	0	21	0
35	022	C1	300	15	02	74 CLEANERS	654.0	5223.0	20E	.	77		0	1	0	0	0	0	4	0
35	022	C1	300	16	01	74 ABSARAKE MILLER EL/SHP&HN	622.0	5204.0	0	.0	77	0	20E	10	0	0	0	0	13	0
35	022	C1	300	16	02	74 3 CLEANE	622.0	5204.0	20E	.	77		0	5	0	0	0	0	6	0
35	022	C1	300	16	03	74 MIX BULK FERTILIZ	622.0	5204.0	0	.0	77	0	20E	2	0	0	0	0	1	0
35	022	C1	300	17	01	74 GRANDIN GOLD LABEL FED/GR	650.0	5230.0	0	.0	77	0	20E	45	0	0	0	0	12	0
35	022	C1	300	18	01	74 HARWOOD FARM.EL/SHIP&HAND	661.0	5205.0	0	.0	77	0	20E	8	0	0	0	0	11	0
35	022	C1	300	18	02	74 2 CLEANE	661.0	5205.0	20E	.	77		0	1	0	0	0	0	11	0
35	022	C1	300	18	03	74 LIQUID FERTL	661.0	5205.0	0	.0	77	0	20E	0	0	0	0	0	0	0
35	022	C1	300	19	01	74 HICKSON GRAIN CO/SHIP&HAN	661.0	5170.0	0	.0	77	0	20E	61	0	0	0	0	94	0
35	022	C1	300	19	02	74 1 CLEAN	661.0	5170.0	20E	.	77		0	0	0	0	0	0	0	0
35	022	C1	300	19	03	74 BULK&LIQUID FERTL	661.0	5170.0	0	.0	77	0	20E	0	0	0	0	0	0	0
35	022	C1	300	20	01	74 HORACE FARM.EL/SHIP&HAND	660.0	5180.0	0	.0	77	0	20E	66	0	0	0	0	96	0
35	022	C1	300	20	02	74 2 CLEANE	660.0	5180.0	20E	.	77		0	7	0	0	0	0		0
35	022	C1	300	20	03	74 1 NAT.GAS DRY	660.0	5180.0	20E	.			0	1	0	0	0	0		0
35	022	C1	300	20	04	74 BULK&LIQUID FERTL	660.0	5180.0	0	.0	77	0	20E	6	0	0	0	0	2	0
35	022	C1	300	21	01	74 HUNTER GRAIN CO/SHIP&HAND	635.0	5228.0	20E	.	77		0	20	0	0	0	0	97	0
35	022	C1	300	21	02	74 4 CLEANE	635.0	5228.0	20E	.	77		0	21	0	0	0	0		0
35	022	C1	300	21	03	74 1 DRY	635.0	5228.0	20E	.			0	3	0	0	0	0		0
35	022	C1	300	21	04	74 BULK&LIQUID FERTL	635.0	5228.0	0	.0	77	0	20E	13	0	0	0	0	7	0

PORTABLE

PORTABLE

A2

FAC. NUMBER ST CO AQ PLT PT YR	PLANT/POINT NAME	UTM COORD.KM HORIZ	VERT	STACK HT. (FT)	STACK DIA (FT)	STACK TEMP (F)	DATA FLOW (ACFM)	DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	SO2	NOX	HC	CO	ALLOWABLE EMISS,TPY PART	SO2
35C22C1300022 01 74	KINDRED FARM.EL/SHIP&HAND	652.0	5168.0	20E	.	77		0	29	0	0	0	0	113	0
35C22C1300022 02 74	5 CLEANE	652.0	5168.0	20E	.	77		0	7	0	0	0	0	15	0
35C22C1300022 03 74	GRIND AND RO	652.0	5168.0	20E	.	77		0	2	0	0	0	0	1	0
35C22C1300022 04 74	BULK FERTL	652.0	5168.0	0	.0	77	0	20E	16	0	0	0	0	5	0
35C22C1300023 01 74	LYNCHBURG FARM EL/SHIP&H	633.0	5181.0	0	.0	77	0	20E	14	0	0	0	0	34	0
35C22C1300023 02 74	2 CLEANE	633.0	5181.0	0	.0	77	0	20E	2	0	0	0	0	1	0
35C22C1300023 03 74	1 LPG DRY	633.0	5181.0	20E	.			0	0	0	0	0	0		0
35C22C1300023 04 74	BULK FERTL	633.0	5181.0	0	.0	77	0	20E	1	0	0	0	0	2	0
35C22C1300024 01 74	RED RIVER GRAIN /SHIP&HND	649.0	5195.0	0	.0	77	0	20E	4	0	0	0	0	9	0
35C22C1300024 02 74	1 CLEAN	649.0	5195.0	20E	.	77		0	1	0	0	0	0	3	0
35C22C1300025 01 74	PAGE EL.CO/SHIPPING&HANDL	608.0	5223.0	20E	.	77		0	5	0	0	0	0	34	0
35C22C1300025 02 74	2 CLEANE	608.0	5223.0	20E	.	77		0	3	0	0	0	0		0
35C22C1300025 03 74	GRINDI	608.0	5223.0	20E	.	77		0	0	0	0	0	0		0
35C22C1300025 04 74	BULK FERTL	608.0	5223.0	0	.0	77	0	20E	1	0	0	0	0	3	0
35C22C1300026 01 74	PROSPER FARM.EL/SHIP&HNDL	651.0	5202.0	20E	.	77		0	18	0	0	0	0	81	0
35C22C1300026 02 74	2 CLEANE	651.0	5202.0	20E	.	77		0	1	0	0	0	0	3	0
35C22C1300026 03 74	BULK FERTL	651.0	5202.0	0	.0	77	0	20E	3	0	0	0	0	3	0
35C22C1300027 01 74	ROMAN MEAL MILLING/SHIP&H	669.0	5193.0	0	.0	77	0	20E	7	0	0	0	0	20	0
35C22C1300027 02 74	3 CLEANE	669.0	5193.0	20E	.	77		0	3	0	0	0	0	10	0
35C22C1300027 03 72	FLAKI	669.0	5193.0	20E	.	77		0		0	0	0	0	7	0
35C22C1300028 01 74	TOWER CITY GRAIN/SHIP&HND	601.0	5197.0	0	.0	77	0	20E	10	0	0	0	0	26	0
35C22C1300028 02 74	1 CLEAN	601.0	5197.0	20E	.	77		0	1	0	0	0	0	4	0
35C22C1300029 01 74	PEAVEY PROD.SERV/SHIP&HND	601.0	5197.0	0	.0	77	0	20E	9	0	0	0	0	14	0
35C22C1300029 02 74	1 CLEAN	601.0	5197.0	20E	.	77		0	1	0	0	0	0	2	0
35C22C1300030 01 74	WALDEN MILLER EL/SHIP&HND	600.0	5225.0	0	.0	77	0	20E	8	0	0	0	0	21	0
35C22C1300030 02 74	3 CLEANE	600.0	5225.0	20E	.	77		0	1	0	0	0	0	18	0
35C22C1300031 01 74	GOLDBERG FD&GRN/SHIP&HNDL	660.0	5194.0	0	.0	77	0	20E	31	0	0	0	0	58	0
35C22C1300031 02 74	2 CLEANE	660.0	5194.0	20E	.	77		0	7	0	0	0	0		0

ST CO AQ	PLT PT	YR	PLANT/POINT NAME	UTM COORD,KM HORIZ	UTM COORD,KM VERT	STACK HT. (FT)	STACK DIA (FT)	STACK TEMP (F)	DATA FLOW (ACFM)	DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	SO2	NOX	HC	CO	ALLOWABLE EMISS,TPY PART	SO2
35C22C1300032	01	74	RED RIVER GRAIN/SHIP&HNDL	660.0	5194.0	20E	.	77		0	16	0	0	0	0	77	0
35C22C1300032	02	74	2 CLEANE	660.0	5194.0	20E	.	77		0	17	0	0	0	0	22	0
35C22C1300032	03	74	1 PROP.OR NAT.GAS DRY	660.0	5194.0	20E	.			0	0	0	0	0	0	1	0
35C22C1300032	04	74	BULK FERTL	660.0	5194.0	0	.0	77	0	20E	33	0	0	0	0	11	0
35C22C1300033	01	74	GOLD LABEL FEEDS/SHIP&HND	660.0	5194.0	20E	.	77		0	5	0	0	0	0	22	0
35C22C1300033	02	74	HAMRMIL,ROLL,BLND,PEL	660.0	5194.0	0	.0	77	0	20E	77	0	0	0	0		0
35C22C1300034	01	74	INTERSTATE SUNFLR/SHIP&HN	660.0	5194.0	20E	.	77		0	2	0	0	0	0	22	0
35C22C1300034	02	74	15 CLEANE	660.0	5194.0	20E	.	77		0	4	0	0	0	0	21	0
35C22C1300034	03	74	1 PROP:DRY	660.0	5194.0	20E	.			0	1	0	0	0	0	5	0
35C22C1300035	01	74	WHTLND FRM.UNION GRN/SHPG	626.0	5196.0	0	.0	77	0	20E	15	0	0	0	0	35	0
35C22C1300035	02	74	2 CLEANE	626.0	5196.0	20E	.	77		0	3	0	0	0	0	9	0
35C22C1300035	03	72	1 HAMMERMI	626.0	5196.0	0	.0	77	0	20E		0	0	0	0		0
35C22C1300036	01	74	WOODS FRM.COOP EL/SHIP&HN	639.0	5171.0	0	.0	77	0	20E	20	0	0	0	0	41	0
35C22C1300036	02	74	3 CLEANE	639.0	5171.0	20E	.	77		0	1	0	0	0	0	10	0
35C22C1300036	03	74	1 LPG DRY	639.0	5171.0	20E	.			0	0	0	0	0	0	1	0
35C22C1300036	04	74	BULK FERTL	639.0	5171.0	0	.0	77	0	20E	4	0	0	0	0	2	0
35C22C1300037	01	74	AMENIA SDEGRN/SHIPNG&HNDL	636.0	5201.0	0	.0	77	0	20E	36	0	0	0	0	65	0
35C22C1300037	02	74	6 CLEANE	636.0	5201.0	20E	.	77		0	1	0	0	0	0	23	0
35C22C1300037	03	74	1 FUEL OIL DRY	636.0	5201.0	20E	.			0	0	0	0	0	0		0
35C22C1300037	04	74	LIQUID FERTL	636.0	5201.0	0	.0	77	0	20E	0	0	0	0	0	0	0
35C22C1300038	01	74	ALICE FARM EL/SHIPNG&HNDL	610.0	5179.0	0	.0	77	0	20E	10	0	0	0	0		0
35C22C1300038	02	74	1 CLEAN	610.0	5179.0	20E	.	77		0	0	0	0	0	0	0	0
35C22C1300038	03	74	FEED GRINDI	610.0	5179.0	0	.0	77	0	20E	1	0	0	0	0	0	0
35C22C1300038	04	72	SELL BULK FERTL	610.0	5179.0	0	.0	77	0	20E		0	0	0	0		0
35C22C1300039	01	74	ARGUSVLLE FARM EL/SHIPEHN	657.0	5213.0	0	.0	77	0	20E	3	0	0	0	0	12	0
35C22C1300039	02	74	3 CLEANE	657.0	5213.0	20E	.	77		0	0	0	0	0	0	1	0
35C22C1300040	01	74	FARMERS EL.CO/SHIPP&HNDL	635.0	5218.0	20E	.	77		0	44	0	0	0	0	193	0
35C22C1300040	02	74	CLEANE	635.0	5218.0	20E	.	77		0	29	0	0	0	0	43	0

I.D. NUMBER						UTM COORD.,KM		STACK DATA					ESTIMATED EMISSIONS, TPY					ALLOWABLE EMISS.,TPY	
ST CO AQ PLT PT YR	PLANT/POINT NAME	HORIZ	VERT	HT. (FT)	DIA (FT)	TEMP (F)	FLOW (ACFM)	PLUME HT	PART	SO2	NOX	HC	CO	PART	SO2
350220130004J 03 74	LPG DRYE	635.0	5218.0	20E	.			0	4	0	0	0	0	8	0
350220130004O 04 74	GRINDING&CELLI	635.0	5218.0	0	.0	77	0	20E	15	0	0	0	0	3	0
350220130004O 05 74	SELL BULK FERTL	635.0	5218.0	0	.0	77	0	20E	9	0	0	0	0	10	0
350220130004I 01 74	BUFFALO CARGILL/SHIP&HNDL	611.0	5197.0	0	.0	77	0	20E	10	0	0	0	0	26	0
350220130004I 02 74	SELL BULK FERTL	611.0	5197.0	0	.0	77	0	20E	1	0	0	0	0	3	0
350220130004Z 01 74	BUFFALO PU PROD.SER/SHP&H	611.0	5197.0	0	.0	77	0	20E	18	0	0	0	0	40	0
350220130004Z 02 74	1 CLEAN	611.0	5197.0	20E	.	77		0	0	0	0	0	0	1	0
350220130004Z 03 74	SELL BULK FERTL	611.0	5197.0	0	.0	77	0	20E	0	0	0	0	0		0
350220130004J 01 74	WALTON EL CO/SHIPNG&HANDL	636.0	5196.0	0	.0	77	0	20E	5	0	0	0	0	14	0
350220130004J 02 74	2 CLEANE	636.0	5196.0	20E	.	77		0	2	0	0	0	0	3	0
350220130004J 03 74	1 PROP.DRYE	636.0	5196.0	20E	.			0	0	0	0	0	0	1	0
350220130004K 01 74	CHAFFEE FRM.COOP.EL/SHP&H	625.0	5181.0	0	.0	77	0	20E	70	0	0	0	0	114	0
350220130004K 02 74	2 CLEANE	625.0	5181.0	20E	.	77		0	27	0	0	0	0	22	0
350220130004K 03 74	1 NAT.GAS.DRY	625.0	5181.0	20E	.			0	10	0	0	0	0	11	0
350220130004K 04 72	LIQ AND BULK FERTL	625.0	5181.0	0	.0	77	0	20E		0	0	0	0		0
350220130004S 01 72	KENT DURAN GRAIN/SHIP&HAD	648.0	5175.0	0	.0	77	0	20E	5	0	0	0	0	8	0
350220130004S 02 72	SELL BULK FERTL	648.0	5175.0	0	.0	77	0	20E	0	0	0	0	0		0
350220130004G 01 74	DURBIN COOP EL/SHIPNG&HND	641.0	5186.0	0	.0	77	0	20E	10	0	0	0	0	24	0
350220130004G 02 74	1 CLEAN	641.0	5186.0	20E	.	77		0	2	0	0	0	0		0
350220130004T 01 74	DBA FARM GRAIN/SHIPNG&HND	619.0	5184.0	0	.0	77	0	20E	11	0	0	0	0	31	0
350220130004T 02 74	2 CLEANE	619.0	5184.0	20E	.	77		0	2	0	0	0	0	4	0
350220130004Q 01 72	DAHLGREN CO/SHIP,HAND,CLE	669.0	5194.0	20E	.	77		0	0	0	0	0	0	16	0
350220130004Q 02 72	DRY	669.0	5194.0	20E	.			0	1	0	0	0	0		0
350220130005O 01 73	D&P TERM.-FARGO/SHIP&HAND	669.0	5194.0	0	.			20E	7	0	0	0	0	18	0
350220130005I 01 74	IND.MOLASSES/DRYER	649.9	5194.8	36	8.5	200	25184	0	21	0	0	0	0		0
350220130005Z 01 74	FARGO MILLS/SHIPING	666.8	5193.9	0	.0	77	0	20E	1	0	0	0	0		0
350220130005Z 02 74	CLEANE	666.8	5193.9	0	.0	77	0	20E	1	0	0	0	0		0
350340172000O 00		.	.		.										

I.D. NUMBER				UTM COORD,KM		STACK DATA					ESTIMATED EMISSIONS, TPY					ALLOWABLE EMISS,TPY	
ST CO AG PLT PT YR	PLANT/POINT NAME	HORIZ	VERT	HT. (FT)	DIA (FT)	TEMP (F)	FLOW (ACFM)	PLUME HT	PART	SO2	NOX	HC	CO	PART	SO2
35C34C1720000 01	DUNN COUNTY POINT SOURCES	.	.		.										
35C34C1720000 02		.	.		.										
35C34C1720001 01 74	DODGE FARMERS ELEV,SHIPPI	712.0	5242.0		.	77		20E	6	0	0	0	0	10	0
35C34C1720001 02 74	GRAIN CLEANI	712.0	5242.0		.	77		20E	1	0	0	0	0		0
35C34C1720002 01 74	DUNN CENTER GRAIN, SHIPPI	680.0	5247.0		.	77		20E	10	0	0	0	0	26	0
35C34C1720002 02 74	GRAIN CLEANI	680.0	5247.0		.	77		20E	1	0	0	0	0	3	0
35C34C1720003 01 73	KILLDEER EQUITY EL,SHIPPI	670.0	5248.0		.	77		20E	12	0	0	0	0	14	0
35C34C1720003 02 73	GRAIN CLEANI	670.0	5248.0		.	77		20E	1	0	0	0	0	3	0
35C34C1720003 03 73	FEED ROLL	670.0	5248.0		.			20E	15	0	0	0	0	5	0
35C34C1720004 01 74	KILLDEER GRAIN CO.,SHIPPI	670.0	5248.0		.	77		20E	6	0	0	0	0	9	0
35C34C1720004 02 74	GRAIN CLEANI	670.0	5248.0		.	77		20E	0	0	0	0	0	4	0
35C34C1720004 03 74	HAMMLLERLE	670.0	5248.0		.	77		20E	3	0	0	0	0	1	0
35C34C1720005 01 74	HALLIDAY FARM EL,SHIPPING	701.0	5248.0		.	77		20E	14	0	0	0	0	46	0
35C34C1720005 02 74	GRAIN CLEANI	701.0	5248.0		.	77		20E	0	0	0	0	0	4	0
35C34C1720005 03 74	FEED ROLL	708.0	5241.0		.	77E		20E	0	0	0	0	0	2	0
35C72C1720000 00		.	.		.										
35C72C1720000 01	MC LEAN CO. POINT SOURCES	.	.		.										
35C72C1720000 02		.	.		.										
35C72C1720001 01 74	FARM.EL&MERCT/SHIP&HANDLI	339.0	5258.0	20E	.	77		0	6	0	0	0	0	40	0
35C72C1720001 02 74	1 CLEAN	339.0	5258.0	20E	.	77		0	4	0	0	0	0	20	0
35C72C1720002 01 74	BUTTE FARM.UN.EL/SHIP&HAN	376.0	5299.0	0	.0	77	0	20E	12	0	0	0	0	32	0
35C72C1720002 02 74	1 CLEAN	376.0	5299.0	20E	.	77		0	2	0	0	0	0	8	0
35C72C1720002 03 74	1 FEED ROLL	376.0	5299.0	0	.0	77	0	20E	4	0	0	0	0	3	0
35C72C1720003 01 74	PV CO.PROD.SERV/SHIP&HAND	333.0	5267.0	0	.0	77	0	20E	10	0	0	0	0	28	0
35C72C1720003 02 74	1 CLEAN	333.0	5267.0	20E	.	77		0	0	0	0	0	0	1	0
35C72C1720004 01 74	FALKIRK FARM EL/SHIP&HAND	342.0	5247.0	0	.0	77	0	20E	27	0	0	0	0	49	0
35C72C1720004 02 74	5 CLEANE	342.0	5247.0	20E	.	77		0	8	0	0	0	0	13	0
35C72C1720005 01 74	GARRISON FARM.UN.EL/SHP&H	318.0	5280.0	0	.0	77	0	20E	31	0	0	0	0	57	0

I.C. NUMBER		UTM COORD.,KM		STACK DATA					ESTIMATED EMISSIONS, TPY					ALLOWABLE EMISS, TPY	
ST CO AQ PLT PT YR	PLANT/POINT NAME	HORIZ	VERT	HT. (FT)	DIA (FT)	TEMP (F)	FLOW (ACFM)	PLUME HT	PART	SO2	NOX	HC	CO	PART	SO2
35C72C1720005 02 74	2 CLEANE	316.0	5280.0	20E	.	77		0	2	0	0	0	0		0
35C72C1720005 03 74	1 GRINDER & 1 ROLL	318.0	5280.0	0	.0	77	0	20E	10	0	0	0	0	3	0
35C72C1720006 01 74	PV CO.PRCD.SERV/SHIPGHAND	318.0	5280.0	0	.0	77	0	20E	25	0	0	0	0	52	0
35C72C1720006 02 74	4 CLEANE	318.0	5280.0	20E	.	77		0	3	0	0	0	0	9	0
35C72C1720007 01 74	EQUITY FARM.EL.MAX/SHIPGH	328.0	5298.0	20E	.	77		0	10	0	0	0	0	52	0
35C72C1720007 02 74	3 CLEANE	328.0	5298.0	20E	.	77		0	1	0	0	0	0	2	0
35C72C1720009 01 74	EQUITY ELGTRADE CO/SHPGHN	.	.	0	.0	77	0	20E	5	0	0	0	0	19	0
35C72C1720009 02 74	4 CLEANE	.	.	20E	.	77		0	3	0	0	0	0	10	0
35C72C1720009 03 74	GRINDI	.	.	0	.0	77	0	20E	18	0	0	0	0		0
35C72C1720010 01 74	PV CO.PRCD.SERV/SHIPGHAND	358.0	5264.0	0	.0	77	0	20E	10	0	0	0	0	25	0
35C72C1720010 02 74	1 CLEAN	358.0	5264.0	20E	.	77		0	3	0	0	0	0	9	0
35C72C1720010 03 74	1 GRINDER & 1 ROLL	358.0	5264.0	0	.0	77	0	20E	6	0	0	0	0	2	0
35C72C1720011 01 72	UNDERWOOD EL.CO/SHIPGHAND	339.0	5258.0	0	.0	77	0	20E	3	0	0	0	0	6	0
35C72C1720011 02 72	1 CLEAN	339.0	5258.0	20E	.	77		0	0	0	0	0	0		0
35C72C1720011 03 72	1 HAMMERMILL & 1 ROLL	339.0	5258.0	0	.0	77	0	20E	1	0	0	0	0		0
35C72C1720012 01 74	BENEDICT FARM.EL/SHIPGHND	344.0	5299.0	0	.0	77	0	20E	16	0	0	0	0	36	0
35C72C1720012 02 74	3 CLEANE	344.0	5299.0	20E	.	77		0	1	0	0	0	0	16	0
35C72C1720012 03 74	1 ROLL	344.0	5299.0	0	.0	77	0	20E	3	0	0	0	0	2	0
35C72C1720013 01 74	MERLE A.LARSON,INC/SHPGHN	347.0	5239.0	0	.0	77	0	20E	30	0	0	0	0	59	0
35C72C1720013 02 74	3 CLEANE	347.0	5239.0	20E	.	77		0	9	0	0	0	0	25	0
35C76C1720000 00		.	.		.										
35C76C1720000 01	MERCER CO. POINT SOURCES	.	.		.										
35C76C1720000 02		.	.		.										
35C76C1720001 01 74	BASIN ELEC.PWR.COOP/BOILE	~~324.3~~ ~~320.0~~	~~5288.9~~ ~~5243.0~~	350	17.5	380	867000	0	~~46~~ ~~400~~	10499	3962	660	1321	2739	27942
35C76C1720002 01 74	MONTANA DAK.UTIL/BOILER	290.0	5238.0	74	5.5	400	29770	0	205	173	54	9	18	58	379
35C76C1720002 02 74	BOILER	290.0	5238.0	74	5.5	400	29770	0	205	173	54	9	18	58	379
35C76C1720002 03 74	BOILER	290.0	5238.0	87	5.5	365	30100	0	205	173	54	9	18	80	433
35C76C1720002 04 74	BOILER	290.0	5238.0	74	5.0	425	37400	0	218	346	108	18	36	654	1092

I.D. NUMBER ST CO AQ PLT PT YR	PLANT/POINT NAME	UTM COORD,KM HORIZ	UTM COORD,KM VERT	STACK DATA HT. (FT)	STACK DATA DIA (FT)	STACK DATA TEMP (F)	STACK DATA FLOW (ACFM)	STACK DATA PLUME HT	ESTIMATED EMISSIONS, TPY PART	SO2	NOX	HC	CO	ALLOWABLE EMISS,TPY PART	SO2
35C76C1720002 05 74	BOILER	290.0	5238.0	74	5.0	425E	37400	0	218	346	108	18	36	654	1092
35C76C1720004 01 74	UNITED PWR.ASSOC/BOILER	~~320.0~~ 323.7	~~5243.0~~ 5239.5	225	15.0	350	816000	0	3822	8448	2682	447	894	2092	20655
35C76C1720005 01 74	BEULAH FARM.UN.EL/SHIPPING	290.0	5238.0	20E	.	77		0	4	0	0	0	0	28	0
35C76C1720005 02 74	2 CLEANE	290.0	5238.0	20E	.	77		0	0	0	0	0	0	3	0
35C76C1720006 01 74	BEULAT PV.CO./SHIPNGEHNDL	290.0	5238.0	0	.0	77	0	20E	9	0	0	0	0	25	0
35C76C1720006 02 74	2 CLEANE	290.0	5238.0	20E	.	77		0	0	0	0	0	0	1	0
35C76C1720006 03 74	GRINDER,ROLLER&HAMMERMI	290.0	5238.0	0	.0	77	0	20E	1	0	0	0	0	1	0
35C76C1720007 01 74	FARMERS GRAIN CO./SHIPPIN	722.0	5241.0	0	.0	77	0	20E	7	0	0	0	0	22	0
35C76C1720007 02 74	2 CLEANE	722.0	5241.0	20E	.	77		0	1	0	0	0	0	3	0
35C76C1720008 01 74	HAZEN FARM EL/SHIPPING&HDL	302.0	5241.0	0	.0	77	0	20E	15	0	0	0	0	36	0
35C76C1720008 02 74	4 CLEANE	302.0	5241.0	20E	.	77		0	0	0	0	0	0	0	0
35C76C1720008 03 74	1 FEED ROLL	302.0	5241.0	0	.0	77	0	20E	2	0	0	0	0		0
35C76C1720000 00		.	.		.										
35C76C1720000 01	OLIVER CO. POINT SOURCES	.	.		.										
35C76C1720000 02		.	.		.										
35C76C1720001 01 74	MINNKOTA PWR.COOP/BOILER	~~326.0~~ 332.0	~~5220.0~~ 5213.7	250	19.0	330	167000	0	5740	17863	5128	851	1701	2932	30225

A-8

AIR EMISSION SOURCES FROM A LURGI DRY-ASH GASIFICATION FACILITY USING LIGNITE COAL

BACKGROUND

This study presents the potential emission sources for a Lurgi mine-mouth gasification process, producing 250 million scfd of either low or high BTU gas from lignite. North Dakota and Montana, located in EPA Region VIII, have vast reserves of lignite, comprising 98 percent of the total U.S. reserves. Low BTU gas is used for industrial fuels or power generating turbines. High BTU gas is used as substitute natural gas.

PROCESS DESCRIPTION

The North Dakota lignite has the following characteristics:

High heating value	6500 BTU
Ash content[1]	7-9%
Moisture content[2]	37%
Sulfur content[2]	0.6%

The Lurgi coal gasification process involves mining lignite, reducing its size to that necessary for gasification, followed by pretreating and blending the fuel. After the lignite is gasified, the low BTU gas is either cleaned by stripping H_2S and tar, or processed through a CO shift converter and a methane synthesis operation, resulting in a

high BTU product. Previous Lurgi systems have had difficulty in processing caking coals. Lignite, a non-caking fuel, can be handled in the gas generator without agglomeration.

Process flow diagrams, illustrated in Figures 1 and 2, explain the various flow streams and potential pollutants from the production of low and high BTU gas.

Lignite preparation is similar for both types of gasification. The mined lignite is crushed and transported to stock piles. The coal from various storage piles is blended prior to secondary crushing. The high moisture content of the fuel (37 percent) will lower uncontrolled emissions. Conveyor transfer points are equipped with water sprays. Crushers have either fabric filters or wet scrubbers to further reduce particulate emissions to the atmosphere.

Lignite storage piles are sources of fugitive dust emissions. Spraying water in the process areas and roads eliminates major sources of fugitive dust.

In the Lurgi process (Figure 3), gasification takes place in a counter-current moving bed of lignite as it falls from the distributor onto the grate. The gas stream leaving the gasifier contains coal dust, oil, naptha, phenol, ammonia, tar, and other constituents. This mixture, after going through a cleaning unit to remove sulfur compounds and tar, is the final product, a low BTU gas of approximately 50 to 100 BTU per scf.

High BTU gas requires additional steps as shown in Figure 2. In the shift conversion section, water is added to the CO rich gas, producing carbon dioxide, hydrogen, and heat. In the methanation reaction section carbon oxides are added to hydrogen rich gas to produce the high BTU gas.

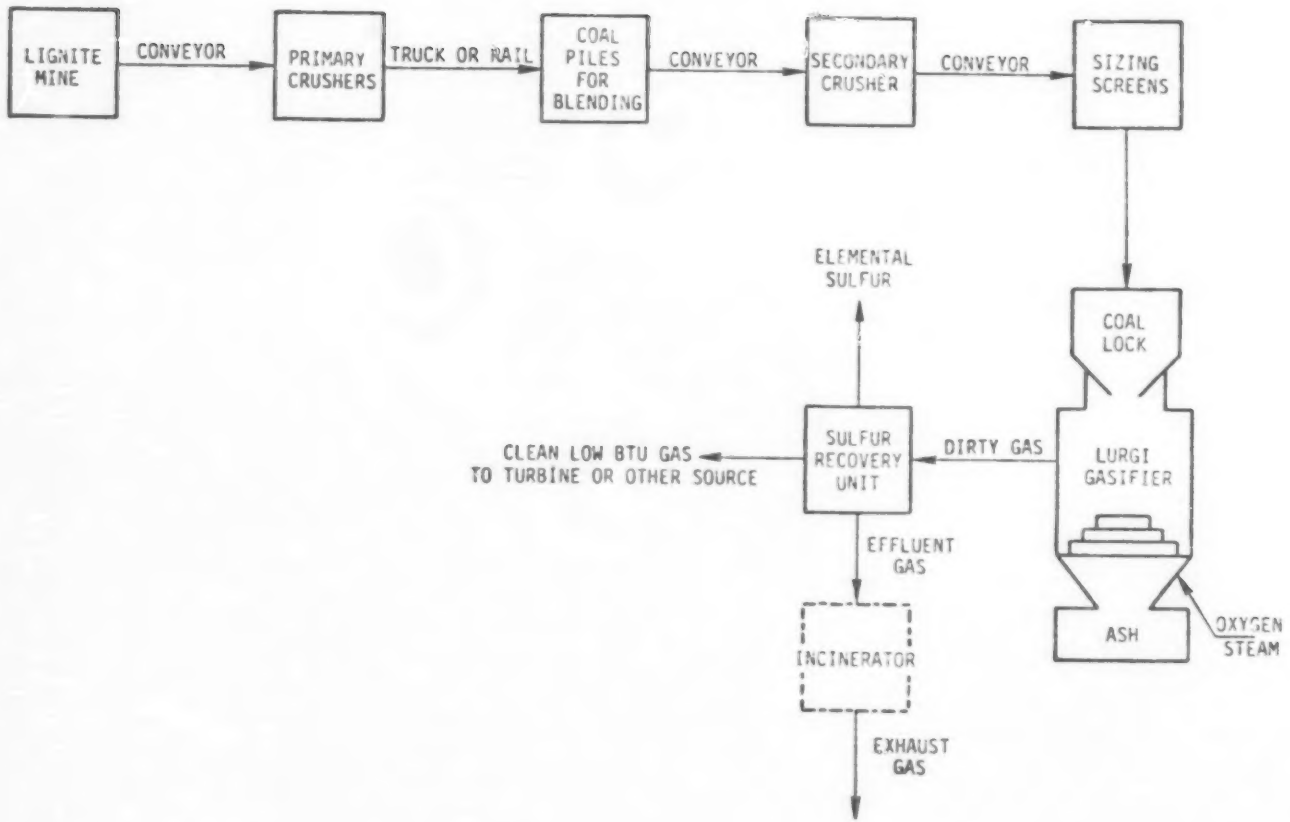

Figure 1. Process flow diagram for Lurgi low BTU gasification process.

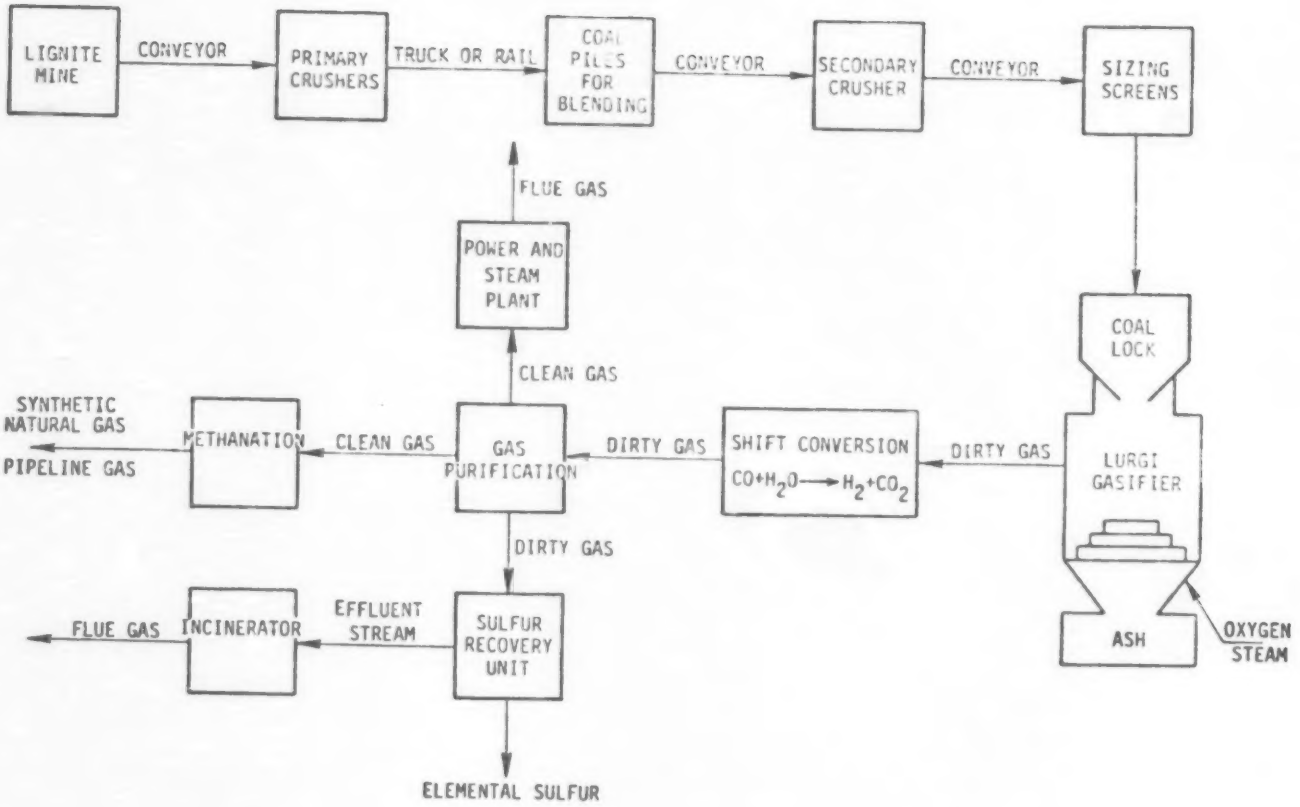

Figure 2. Process flow diagram for Lurgi high BTU gasification process.

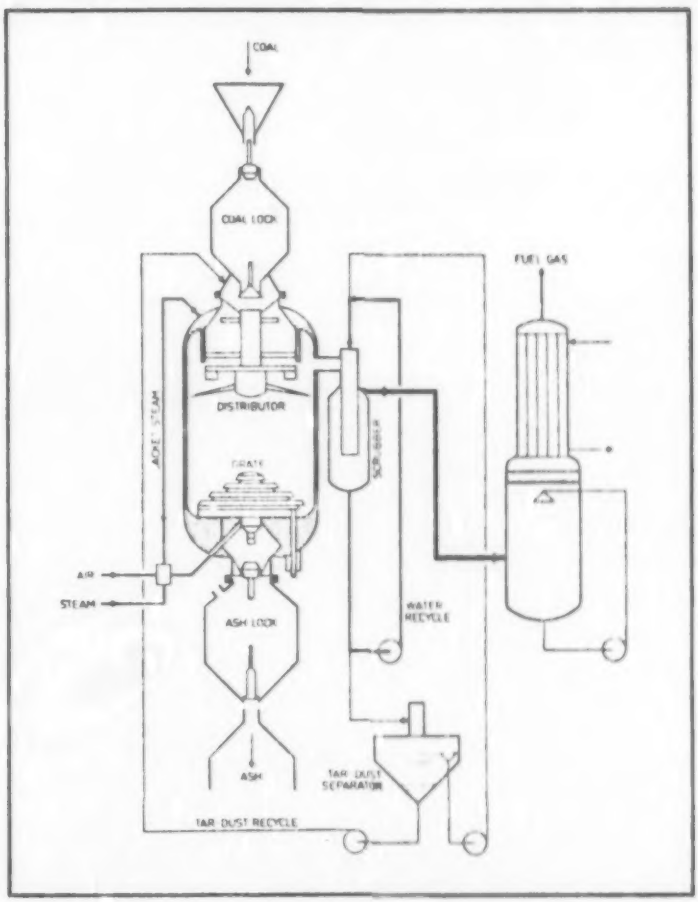

Figure 3. Lurgi pressure gasification for fuel gas production.

(Lurgi Clean Fuel Gas From Coal Publication 0 1007/10.71)

EMISSION SOURCES

The primary potential for emitting particulate matter from a Lurgi system occurs between the mine and the gasifier. These sources include crushing, storing, sizing, and all process transfer points. If the power plant fires lignite or coal fines, it may also be a major source. Incineration/super heater sections fire a gaseous fuel, and therefore are not particulate sources. A study of pollutant control of fuel gasification processes found little or no test data for fuel handling emissions.[3]

The Compilation of Air Pollutant Emission Factors[4] contains no crushing, drying, and sizing information specifically for coal. There are emission factors for primary and secondary crushing or rock and stone products, these given as 0.5 lb/ton (0.025 percent) and 1.5 lb/ton (0.075 percent) respectively. Although moisture content is unavailable, one can assume if these values are compared to lignite crushing, the lignite emissions would tend to be much lower, due to the high moisture content (37 percent) of the mined lignite.

Amounts of coal dust lost during handling, crushing, and blending of coals may range from 0.01 to 0.1 percent.[5] The portion of losses entering the atmosphere is not available. If it is assumed that one fourth of the total dust lost enters the atmosphere, particulate air pollutants range from 0.0025 to 0.025 percent (0.05 to 0.5 lb/ton of coal).

The following uncontrolled emissions are estimated from the identified sources, based on a total loss of 0.020 percent and relative emission rates for the individual processes similar to those for rock crushing:

Source	Uncontrolled particulates, % of lignite processed	lb/ton of lignite processed
Primary crusher	0.001	0.02
Secondary crusher	0.003	0.06
Screening	0.005	0.10
Coal piles and blending	0.005	0.10
Transfer points (total)	0.006	0.12
Total	0.020	0.40

The gas stream leaving the Lurgi gasifier contains H_2S concentrations of 0.32[6] to 0.45[7] percent. Various processes (Stretford, Rectisol, Claus) remove hydrogen sulfide from the gas stream. Roughly, 94 to 99 percent of the sulfur that enters the unit is removed and produces high quality elemental sulfur. The effluent stream from the sulfur recovery unit contains 770 ppm of S as H_2S.[6]

The sulfur recovery effluent stream must be either scrubbed, incinerated, or fed through the boiler. In a plant employing the Lurgi process to produce 250 MM scf of synthetic natural gas, the incinerated flue gas composition contains about 295 ppm SO_2 and 58 ppm NO_x.[6] Flue gas desulfurization may be required in this example, since the estimated SO_2 level of 1.8 lb/MM BTU is above the allowable regulations.

The power requirements for a 250 MM scfd gasification complex are usually produced within the facility. The flue gas composition coming from a high BTU gas-fired power plant stack includes about 74 ppm SO_2 and 128 ppm NO_x.[6] This boiler accounts for 2700 MM BTU/hr, thus producing emission levels of 0.16 lb of SO_2 per MM BTU, and 0.2 lb of NO_x per MM BTU. However, emission factors for lignite-fired boilers are 1.4-1.5 lb/10^6 BTU for SO_2 and 0.5-0.7 lb/10^6 BTU for NO_x.

Hydrocarbons are emitted to the atmosphere due to incomplete combustion and from leaks in hydrocarbon by-product and storage. The rate of uncontrolled hydrocarbon emissions is 0.007 lb/MM BTU measured as methane.[6] With good engineering design, most of the storage tank and by-product hydrocarbon emissions can be captured and incinerated or fed into the boiler.

The fuel properties for the fuel in the referenced report[6] are compared to the North Dakota fuel analyses to obtain emission factors using lignite:

FUEL CHARACTERISTICS

Component	Reference[6]	North Dakota lignite[1,2]
Sulfur, %	0.95	0.6
Moisture, %	16.5	37.0
Ash, %	17.3	8.0
HHV, BTU	8872.0	6500.0

$$SO_2 \text{ emission conversion factor} = \frac{0.6}{0.95} \times \frac{8872}{6500} \times 0.862$$

$$NO_x \text{ emission conversion factor} = \frac{8872}{6500} = 1.36$$

Figures 4 and 5 display uncontrolled emissions from a 250 MM scfd lignite gasification plant producing low and high heating value gas using the gas conversion factors.

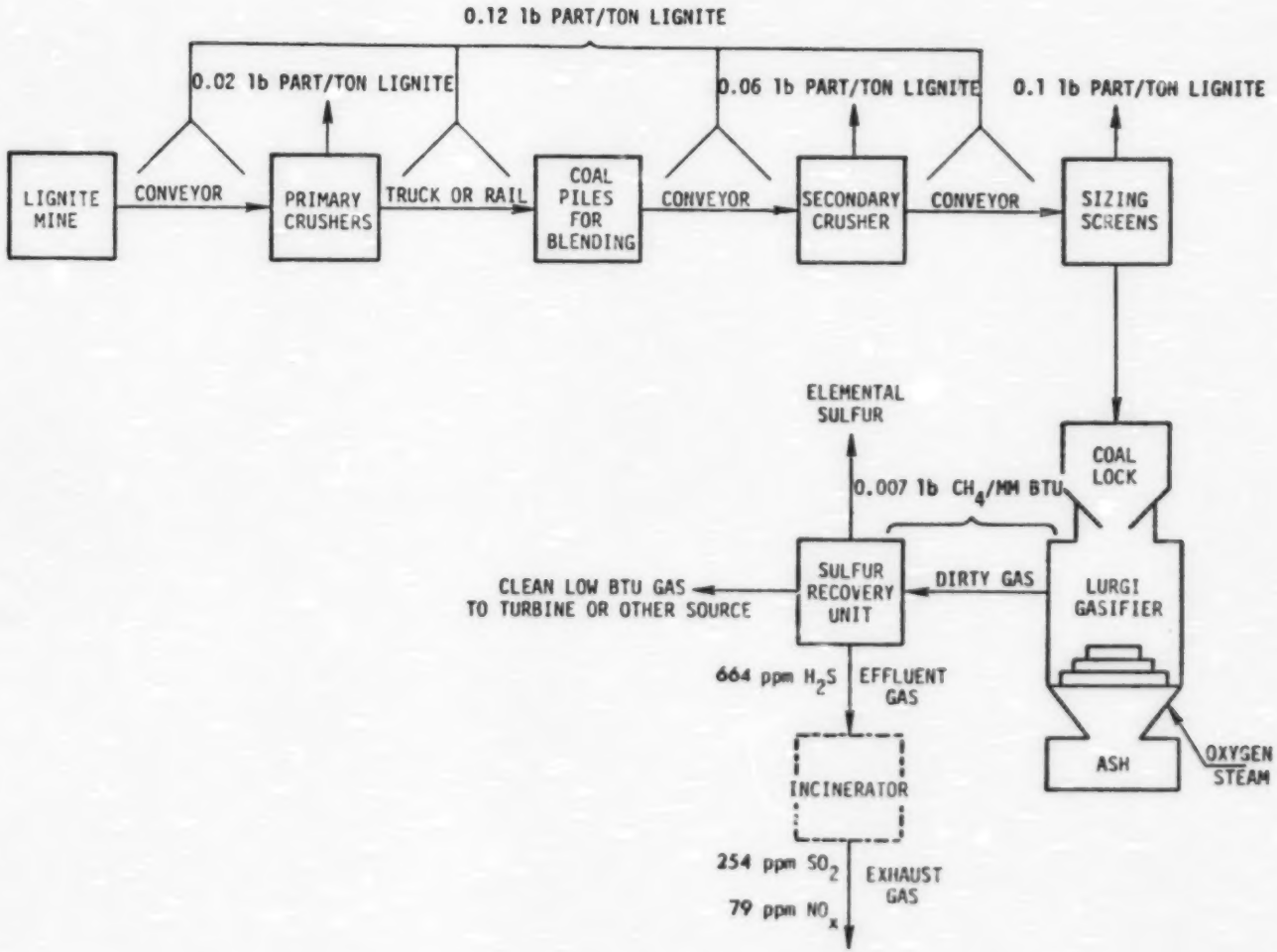

Figure 4. Uncontrolled emissions from Lurgi low BTU gasification process.

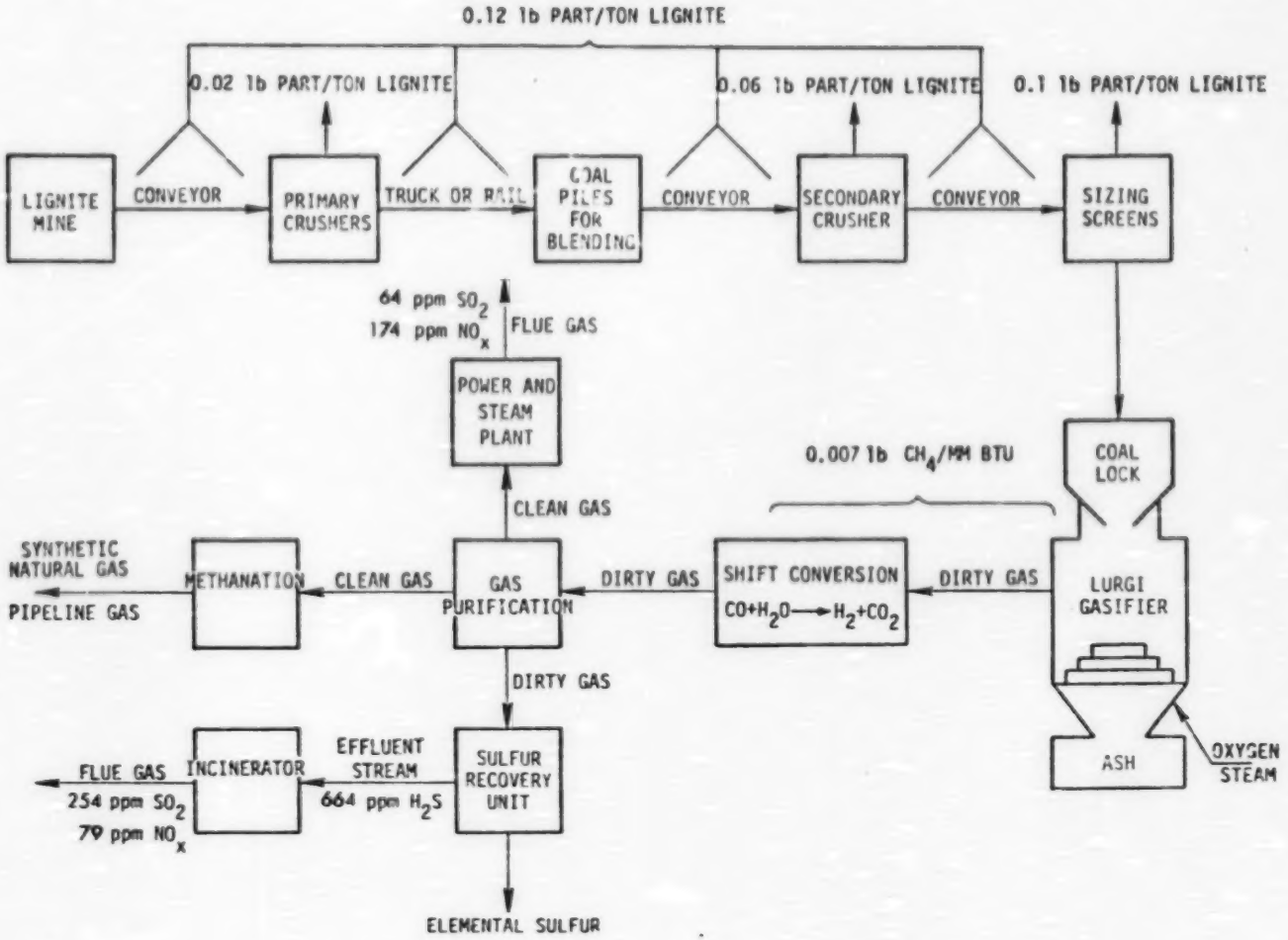

Figure 5. Uncontrolled emissions from Lurgi high BTU gasification process

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4. Compilation of Air Pollutant Emission Factors, Second Edition, U.S. EPA, Office of Air Programs Publication AP-42, 1973.

5. Evaluation of Process Alternatives to Improve Control of Air Pollution from Production of Coke, Battelle Memorial Institute NAPCA Contract No. PH22-68-65, 1970

6. Evaluation of Pollution Control in Fossil Fuel Conversion Processes, Exxon Research and Engineering Company U.S. EPA Control Systems Laboratory, Contract No. 68-02-0629, ROAP No. 21ADD-023, 1974.

7. Cost Estimate for a 500 Billion BTU/Day Pipeline Gas Plant Via Hydrogasification of Lignite, Office of Coal Research, Department of the Interior, Contract No. 14-01-0001-381, Report No. 22, Undated.